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Manager

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WILLARD CHEVALIER
Vice-President

San Francisco Mines of Mexico, Ltd., whose operations are described in this issue, is one of the far-flung interests of Union Corporation, Ltd., a British company. It has claim and land holdings in the Witwatersrand district of South Africa, and owns shares and debentures in mining companies on the Rand, and in Rhodesia, Australia, Yugoslavia, and Mexico.

*

Installation of a steam-turbine-driven centrifugal compressor of 12,000-c.f.m. capacity at Fresnillo, Mexico, at an altitude of 7,300 ft., is expected not only to effect operating economies and solve a power problem for the Fresnillo Company but also to show something new in compressing air for mine use, if the machine proves its reliability. James T. Hill, superintendent of power plant for the company, will describe the new unit for *E. & M. J.* readers in the September issue.

*

Power Conference. Engineers, scientists, and economists of the world will gather in Washington, D. C., Sept. 7–12, for the Third World Power Conference. Before and after the meetings nine separate technical study tours will be made to inspect hydroelectric power plants, research laboratories, electrical manufacturing plants, large and small dams, and metropolitan railroad terminals. The sessions in Washington will be devoted to a study of "The National Power Economy." Representatives of nearly fifty nations will participate.

*

Every Clay Bank is not as yet an aluminum mine, even though the production of the light metal from low-grade aluminiferous deposits is chemically possible. Questions of cost are all-important. Economic considerations rule. A brief discussion of this subject will appear shortly.

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Security Registration. In order to set up accounts for employees eligible for Federal old-age benefits, the Social Security Board plans to conduct a nation-wide registration of employees. Since many persons have exactly the same name, it will be necessary for the Board to assign a "Social Security Benefit Account" number to each person, so that when he reaches age 65 there will be an official record of his employment and earnings. This registration and assignment of numbers is voluntary. Decision has not yet been reached as to whether the registration will be held on or off the premises of the employer.

*

First American Patent. From the records of the Colony of the Massachusetts Bay in New England, April 2, 1641: "Wheras Samu: Winslow hath made a pposition to this Court to furnish the countrey wth salt at more easy rates than otherwise can bee had, & to make it by a meanes, & way, wch hitherto hath not bene discovred. It is therefore ordered, that if the said Samu: shall within the space of one yeare, set upon the said worke, hee shall enjoy the same, to him & his associats, for the space of 10 yeares, so as it shall not bee lawful to any other pson to make salt after the same way during the said years; pvided, nevrthelesse, that it shall bee lawfull for any pson to bring in any salt, or to make salt after any othr way dureing the said tearme/."

*

Mine Waste Disposal by means of self-dumping barges towed by tugboat is now practiced by Alaska Juneau and will be described in an early issue. The barges are so built that either top or bottom can serve as deck, the side that is uppermost at loading time carrying the rock. This is then consigned to Gastineau Channel's depths.

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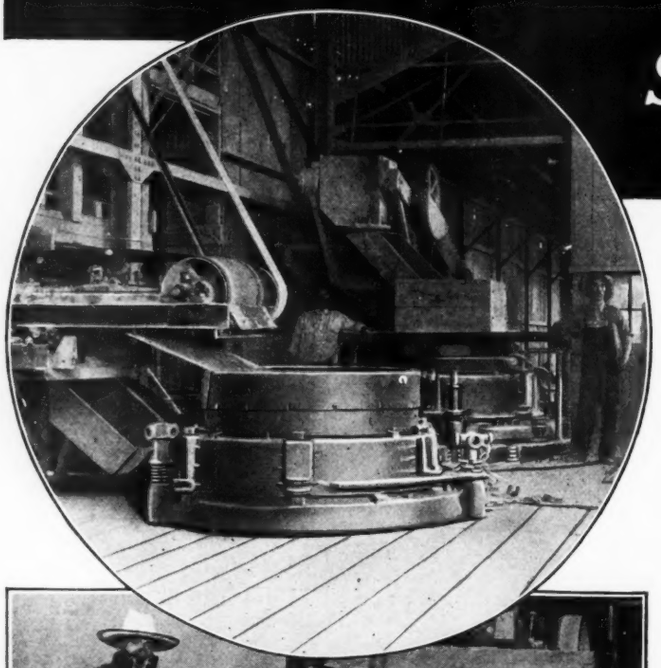
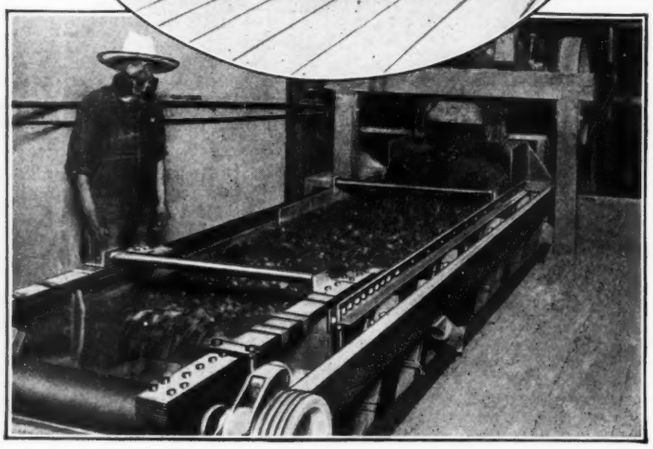
CRUSHING and SCREENING at San Francisco Mines





The four-foot Standard Cone is set to deliver a ¾" product, while the four-foot Short Head is set at ⅜". This Short Crusher operates in closed circuit with the 42" x 10' Symons Screen shown in the lower illustration. This screen handles about 120 tons of dry ore per hour.

The San Francisco Mines in Mexico was among the first to install a Symons Cone Crusher. This was in 1926. The four foot Standard Cone is still being used for the first reduction, but it is now followed by a four foot Symons Short Head Cone installed in 1934 to make the final reduction at ⅜ inches. This combination of Standard and Short Head Cones is a practice now being followed by many mining companies. It provides a much finer product, a more desirable ball mill feed and a greatly reduced crushing cost.

The Symons flat screen is an important link in this successful crushing and screening combination.

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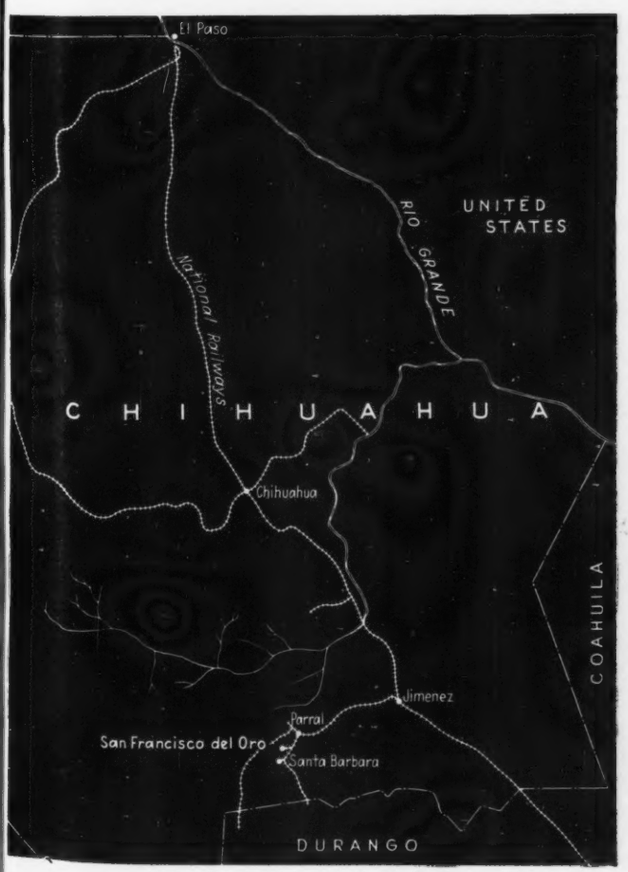
San Francisco: J. B. HUTTL, Assistant Editor; G. J. YOUNG, Consultant
Washington, D. C.: PAUL WOOTON

Volume 137 AUGUST 1936 Number 8

South of the Rio Grande

IN OFFERING OUR READERS an issue covering the operations of San Francisco Mines of Mexico, Ltd., we present a group of articles by members of the company's staff that will be of international interest. Although mining and milling methods have many points in common regardless of location, nevertheless each important enterprise has some distinctive problems and develops its own methods of operation that are frequently suggestive to operators in other mining areas.

THAT there is uniformly high efficiency in winning metals in the principal mining countries of the world is due in no small measure to the freedom and generosity with which mining engineers disseminate the results of their work, either by publication or by their habit of international travel. In this instance the industry is indebted to the management and staff of the San Francisco organization for making possible the publication of a story of well-planned modernization and expansion.



ADVERSE CONDITIONS in lead and zinc markets led to a suspension of operations at San Francisco del Oro at the end of 1931, and the mines remained closed for two years. In the interim key men on the staff and a nucleus of labor were retained, and the entire plant was kept in first-class condition against the time when operations might be resumed. This did not occur until January, 1934, at which time it was decided to inaugurate a two-year program of expansion, which had been suspended prior to closing in 1931. Plans called for the expenditure of about one million dollars. The promptness with which the program was resumed and the fact that it was completed ahead of schedule are a credit to the policy of the management during the period of suspension.

SAN FRANCISCO ORES are of the low-grade complex type, containing lead, zinc, silver, and gold, occurring in both sulphide and oxidized deposits, which require separate treatment. Separation and concentration of the lead and zinc minerals are accomplished by selective flotation. In addition to the mining and milling methods at San Francisco, special interest attaches to the construction and operation of nearly five miles of aërial tramway, over 3,000 feet of which runs through an adit to an underground loading station connected with one of the principal shafts. Further interest will be found in the social aspects of mining in Mexico, and in the methods adopted by the San Francisco organization to meet the policies of the Mexican Government with respect to labor.

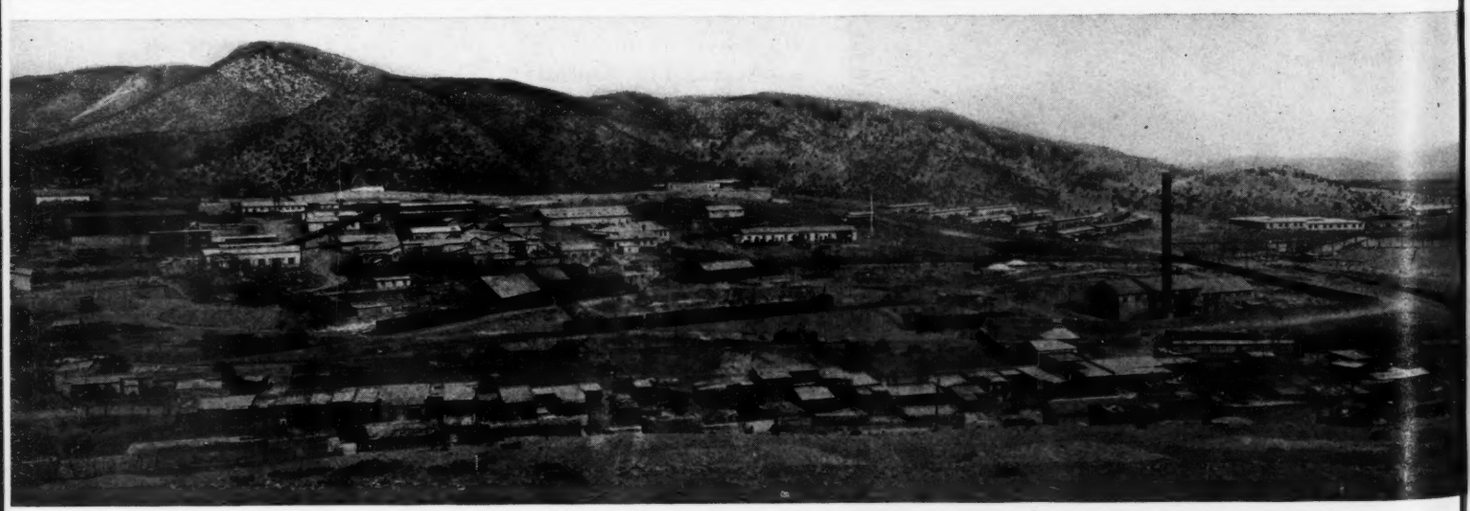
E. A. STROUT
General Manager

The Enterprise of the San Francisco Mines of Mexico

THE INCORPORATION PAPERS of the San Francisco Mines of Mexico, Ltd., were taken out on the 27th day of March, 1913, in England. The address of the company and of its Registered Office is Union Corporation, Ltd., 95 Gresham St., London. Directors are: The Right Hon. the Earl of Denbigh, G.C.V.O. (Chairman); Sir Albert James Bennett, Bart.; Thomas Ford; Walter Maclachlan; Cyrus Thomas Pott; Sir Henry Strakosch, G.B.E.; and Clive Errington Temperley, O.B.E., M.C.

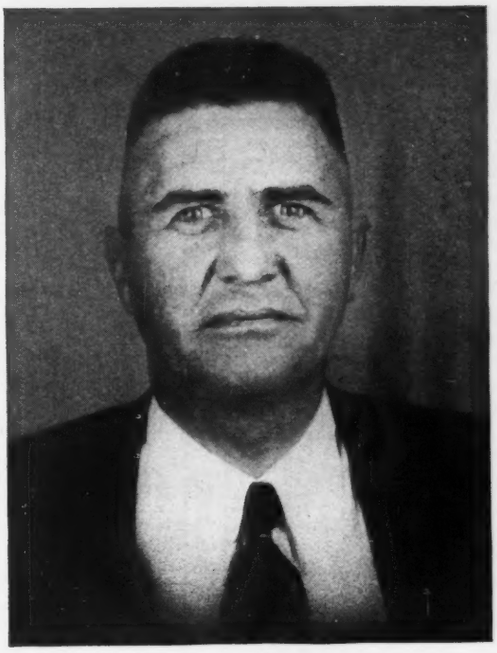
Mine offices and mineral claims of the company and of a subsidiary, Compañia Minera Plomosa, S.A., are at San Francisco del Oro, in the State of Chihuahua, Mexico, where operations including mining, milling, and construction are executed by 39 foreign employees, 41 Mexican salaried employees, and 2,357 Mexican workmen. (The figures are for May, 1936.)

Until 1922, when the flotation process was introduced, metallurgical operations consisted of testing ores and small-scale milling. The company's progress since 1922 is recorded in the statistics given on page 380.



"LA HACIENDA," a Spanish word meaning the center of administration or mechanical operations. Included within the spacious area surrounded by the 10-ft. stone wall are the terminal of the wire-rope tramway that brings the various ores from the mines and the bins to which they are delivered; also the crushing plant and the 1,700-ton mill, consisting of two 250-ton carbonate units and a 1,200-ton sulphide section. A third 250-ton unit is being added. New shops are also under construction. A broad-gage railway enters the property. Houses in the foreground outside of the wall are part of the town of San Francisco del Oro.

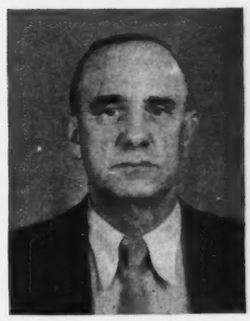
H. L. DAUTH
General Mine Superintendent



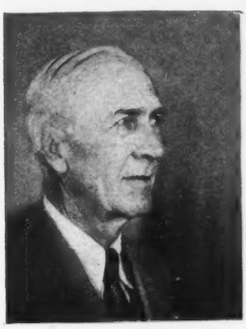
W. J. HILL
General Superintendent

G. O. DESHLER
Mill Superintendent

L. C. OVERTON
Supt. Mechanical Department



W. G. CAMPBELL
Supt. Aerial Transportation

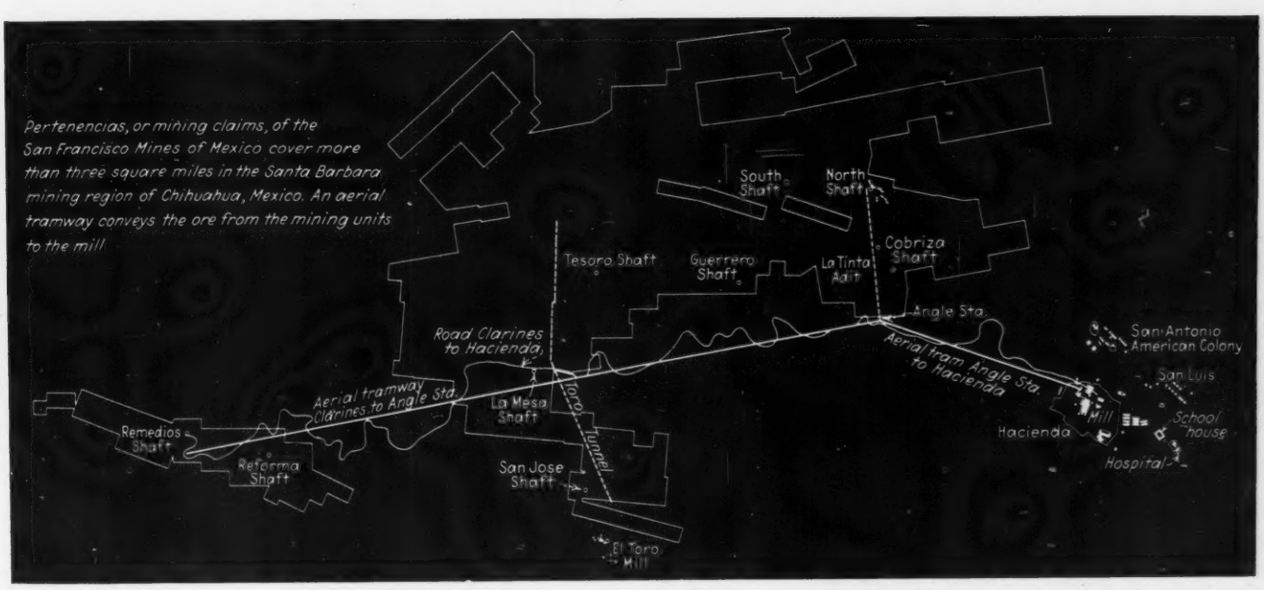


W. E. MASHBURN
Supt. Electrical Department

H. G. DUDLEY
Chief Mine Engineer

R. RANGEL
Ingeniero Responsable

W. E. WIEGAND
Personnel


Pertenencias, or mining claims, of the San Francisco Mines of Mexico cover more than three square miles in the Santa Barbara mining region of Chihuahua, Mexico. An aerial tramway conveys the ore from the mining units to the mill.
South Shaft
North Shaft
Tesoro Shaft
Guerrero Shaft
La Tinta Adit
Cobriza Shaft
Angle Sta.
Road Clarines to Hacienda
Aerial tramway Clarines to Angle Sta.
Aerial tram Angle Sta. to Hacienda
La Mesa Shaft
Toro Tunnel
Remedios Shaft
Reforma Shaft
San Jose Shaft
El Toro Mill
San Antonio American Colony
San Luis
Mill
School house
Hacienda
Hospital

• • • A Statistical Picture of the Progress of the San Francisco Mines of Mexico • • •

GROWTH OF MINERAL AREAS, DEVELOPMENT, AND ORE RESERVES

Fiscal Year	MINERAL AREAS (HECTARE = 2.4711 ACRES) Owned Hectares	Leased Hectares	Total Hectares	Ore Developed, Metric Tons	MILLED Sulphides, Metric Tons	Carbonates and Residues, Metric Tons	Total, Metric Tons	RESERVES End Year, Metric Tons
1921	102.3	.....	102.3	91,940	.....	.....	.....	91,940
1922	102.3	.....	102.3	161,267	49,207	34,368	83,575	204,000
1923	102.3	.....	102.3	250,483	88,663	.....	88,663	365,820
1924	165.3	.....	165.3	203,620	133,590	.....	133,590	435,850
1925	209.5	.....	209.5	376,730	148,580	.....	148,580	664,000
1926	272.0	.....	272.0	369,350	153,050	52,010	205,060	880,300
1927	287.9	.....	287.9	773,300	207,600	71,730	279,330	1,446,000
1928	308.9	.....	308.9	723,030	296,030	3,980	300,010	1,873,000
1929	460.8	.....	460.8	319,300	303,900	3,550	307,450	1,888,400
1930	507.3	.....	507.3	759,480	337,480	.....	337,480	2,310,400
1931	507.3	21.0	528.3	397,830	393,390	.....	393,390	2,314,840
1932	507.3	21.0	528.3	26,020	98,940	.....	98,940	2,241,920
1933	507.3	56.4	563.7	.....	.....	.....	.....	2,241,920
1934	522.2	56.4	578.6	402,780	223,130	3,340	226,470	2,421,570
1935	530.4	215.1	745.5	720,850	390,670	56,410	447,080	2,695,340
				5,575,980	2,824,230	225,388	3,049,618	

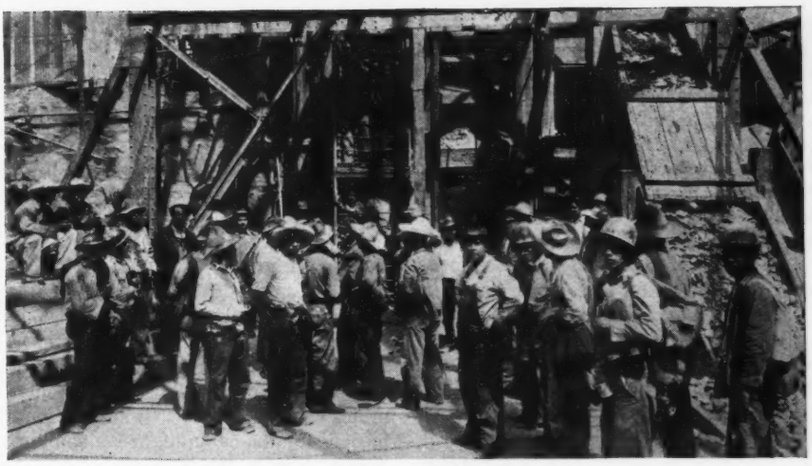
GRADE OF ORE	Milled, Metric Tons	Gold, Gm.	Silver, Gm.	Lead, %	Copper, %	Zinc, %
Sulphides	2,824,230	0.964	259.6	8.2	.63	10.8
Residues	168,978	0.849	292.5	3.4	.34	16.7
Carbonates	59,717	3.491	219.4	4.0	.36	3.7

Reserves 30 Sept. 1935	Metric Tons	Gold, Gm.	Silver, Gm.	Lead, %	Copper, %	Zinc, %
Sulphides	2,014,480	1.94	196.0	7.4	0.8	8.4
Carbonates	680,860	3.57	193.0	5.2	0.4	3.7

OPERATING COSTS IN U. S. CURRENCY PER METRIC TON (2,204.6 LB.) MILLED

	Milled, Metric Tons	DEVELOPMENT Amount	DEVELOPMENT Per M/T	SHAFTS Amount	SHAFTS Per M/T	UNWATERING Amount	UNWATERING Per M/T	STOPING Amount	STOPING Per M/T
1924	133,590	$65,055.79	$0.487	$27,533.90	$0.206	$43,995.45	$0.329	$159,681.58	$1.195
1925	148,580	123,340.80	0.830	70,684.83	0.476	60,180.13	0.405	200,222.42	1.348
1926	205,060	122,573.71	0.598	58,485.48	0.285	54,416.74	0.265	197,669.12	0.964
1927	279,330	199,854.53	0.715	86,366.45	0.309	61,725.81	0.221	293,990.31	1.053
1928	300,010	226,652.89	0.755	55,583.29	0.185	60,965.69	0.203	293,596.87	0.979
1929	307,450	142,793.90	0.464	52,927.51	0.172	70,834.85	0.230	367,730.20	1.196
1930	337,480	92,570.78	0.274	13,967.98	0.041	49,554.74	0.147	340,570.11	1.009
1931	393,390	66,163.52	0.168	22,292.09	0.057	41,817.66	0.106	344,862.52	0.877
1932 (3 mo.)	98,940	7,359.23	0.074	.....	.....	10,146.15	0.103	62,819.45	0.635
1933	.....	.....	.....	.....	.....	.....	.....	.....	.....
1934 (9 mo.)	226,470	116,747.59	0.516	1,336.48	0.006	31,757.00	0.140	223,473.82	0.987
1935	447,080	207,525.59	0.464	62,901.83	0.141	40,117.31	0.090	477,676.75	1.068

	TRAMMING HOISTING Amount	TRAMMING HOISTING Per M/T	AERIAL TRANSPORTATION Amount	AERIAL TRANSPORTATION Per M/T	MILLING Amount	MILLING Per M/T	GENERAL EXPENSE Amount	GENERAL EXPENSE Per M/T	TOTAL Amount	TOTAL Per M/T	MATERIALS In Warehouse and Transit, End of Year
1924	$42,642.35	$0.319	$16,976.57	$0.127	$267,336.85	$2.001	$155,118.80	$1.162	$778,341.29	$5.826	$263,115.18
1925	46,640.93	0.314	24,279.67	0.163	322,084.45	2.168	148,753.85	1.001	996,187.08	6.705	267,956.30
1926	52,724.88	0.257	17,300.12	0.085	438,249.21	2.137	187,000.25	0.912	1,128,419.51	5.503	420,610.05
1927	85,248.17	0.305	27,741.25	0.099	547,386.61	1.960	248,202.38	0.889	1,550,515.51	5.551	348,190.78
1928	103,120.01	0.344	24,675.73	0.082	506,113.33	1.687	241,668.03	0.806	1,512,375.84	5.041	311,769.77
1929	109,998.53	0.358	30,647.89	0.100	499,451.88	1.625	224,314.44	0.730	1,498,699.20	4.875	312,615.04
1930	124,732.78	0.370	22,547.50	0.067	487,279.23	1.444	193,495.13	0.573	1,324,718.25	3.925	293,013.36
1931	137,340.00	0.349	17,091.72	0.043	462,148.13	1.175	170,015.05	0.432	1,261,730.69	3.207	331,532.83
1932 (3 mo.)	30,333.76	0.307	2,977.88	0.030	101,663.23	1.027	47,298.10	0.478	262,597.80	2.654	323,323.52
1933	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	311,644.97
1934 (9 mo.)	86,890.40	0.384	12,342.49	0.054	237,992.60	1.051	124,864.46	0.551	835,404.84	3.689	285,714.85
1935	176,316.50	0.394	16,199.03	0.036	417,316.40	0.934	190,828.80	0.427	1,588,882.21	3.554	308,359.38



LOWERING MEN on the afternoon shift at the North Shaft, San Francisco mine. Each of the main hoisting compartments is equipped with a combination skip and double-deck cage

Mining . . . and . . . Geology

Operations Planned To Reach 2,000 Tons Per Day

Shows Extensive Mineralization —Depth Yet to Be Proved

Herman L. Dauth

General Mine Superintendent

THE MINING TOWN of San Francisco del Oro is situated in the southern part of the State of Chihuahua, in Mexico. It is in the district of Hidalgo, about 27 km. west of the town of Parral.

Until recently, three methods of travel were available to reach the town from the nearest port of entry, El Paso, Tex., which is due north. One can reach it by rail, from El Paso to Jimenez, on the through train to Mexico City. At Jimenez a change is made to a feeder line which serves the districts west of this point. The distance, 685 km., requires 15 hours. As San Francisco del Oro has freight service only, the trip from Parral is made by automobile, requiring some 40 minutes' ride. One can also make the trip by automobile from El Paso, which at present takes 12 to 13 hours, the distance being 735 km.

Formerly, the third mode was by airplane, but no service has been available since November, 1935, when it was discontinued. The flight from El Paso required about three hours, including a stop at Chihuahua, where immigration authorities checked passports.

In the region in which the town is situated, the climate can be called arid. The greater part of the plains from El Paso to Jimenez, which are at an elevation of about 1,000 m., is mostly desert, renowned for cattle ranches. From there to San Francisco del Oro there is an increase in elevation of about 1,000 m. (the hacienda is 2,000 m. above sea level). Vegetation is scarce, except after the rainy season, when grass and trees are green. On the average the rainy season lasts from the middle of July until Oct. 1, but shorter seasons of slight rainfall are not uncommon.

The temperature is delightful. May is generally the hot month, about 30 deg. C. December and January provide the winter, when the mercury might drop a few nights to zero C. A blanket or blankets can be used on your bed the entire year.

The topography of the district is gentle. The country rocks are shales. Small valleys where farming and cattle growing are common lie just east of the camp. From these, small rolling hills arise, mostly weathered into rounded forms. The hills, which reach about 2,150 m., are covered with a basalt flow which forms mesas. These are of various sizes, from small areas on isolated hills scattered around the valleys to larger ones back towards the west, where the hills run up into a branch of the Sierra Madres. These are made up of igneous intrusives, which are rugged and steep, reaching an elevation of 3,700 m. The vegetation in the foothills is scrub oak and a coarse grass; the high mountains have pines which reach heights of twenty meters.

Geology—The geology of the properties under development at San Francisco del Oro, as so far studied, is comparatively simple from a mining and development point of view. The orebodies occur as fissure veins in a series of flatly dipping calcareous shales. Igneous activity, as well as faulting, has been post-mineral.

The veins are of the simple and fault-fissure type, with values confined entirely within the walls. The only evidence of mineralization extending into the walls is a zone of extremely hard shale found for varying distances from the veins. Vein filling is predominately quartz with appreciable amounts of calcite and fluorite. Some veins seem to be the result of the filling of an open fissure of some width; others are plainly the result of successive periods of reopening and mineralization. That mineralization covered a long period and came in different stages is shown by the post-mineral faulting of the Brown vein by the Bronces fault, which was subsequently mineralized (both veins being of major importance economically), and the faulting of the Hill vein by the Y vein. The general strike of the more important vein systems is within a few degrees of east or west from the north-south direction, although veins of considerable importance strike as much as 30 deg. off north-south; to date, however, no economic mineralization has been encountered having a predominately east-west strike.

Veins dip both easterly and westerly, the more regular and important ones in the San Francisco mine having the easterly (as opposed to the bedding) dip, whereas in the Clarines and El Toro units veins dip in the same direction as the bedding. Dips are generally steep—above 60 deg.—but veins dipping with the bedding are inclined at times to flatten off and run along the beds. In such cases the section of the vein following the bedding is recognizable only with difficulty, there being no more than a highly silicified bedding sparsely and erratically impregnated with mineral. Apparently, the force causing the fracture moved along the bedding without causing an open fracture. Such veins as have been definitely recognized as faults are west-dipping. Reference to the geologic plan of Level 7 of the San Francisco mine and its complementary sections will give a fair idea of the vein system in that mine. The vein systems of the different mines are distinct, one from another.

Development to date has not been sufficient to give definite information as to the vertical range of economic mineralization. In the San Francisco vein the range is indicated but not definitely proved. This vein shows economic min-

eralization from the surface outcrop to Level 9, a vertical range of 480 m., the oxide zone extending to 130 m. below the outcrop. On Level 9 the length of the oreshoot has shortened considerably, values have dropped off most noticeably, and the vein has become highly siliceous. Further development of this vein below Level 9 has been stopped, although it is planned to diamond drill below this horizon when development on other veins has reached a point from which such drilling can be done advantageously. Evidence of the vertical range is also shown in the Footwall and Cobriza veins, both turning siliceous with depth. The vertical range of economic mineralization probably will lie between 250 and 400 m.

Oreshoots are generally long, and to date, with one exception, no development has followed a vein for any distance past its economic oreshoot. This one exception indicates that on the narrower veins at least there is reason to hope for more than one shoot. The end of an oreshoot is usually shown, first by decreasing economic values and then by pinching or "horsetailing" of the vein. Development indicates that oreshoots will prove to be roughly in the shape of a parachute: the San Francisco vein, for example, shows a shoot length of 750 m. on Level 1, a length of 1,050 m. on Level 5, and a 350-m. length on Level 9. Excluding unusual orebodies such as the San Francisco vein, it seems that an oreshoot length of between 400 and 500 m. can reasonably be expected.

Most veins so far developed are traceable to outcrops. This may be because no prospecting has yet been done toward the discovery of blind veins. One partly developed vein, the Z vein, appears to be blind. Even in this case, however, the outcrop may be covered by the basalt capping. The veins differ widely in the ratio of economic minerals, as Table I shows.

Igneous Rocks—A considerable part of the San Francisco-El Toro area is overlain by a basalt capping of varying thickness (La Mesa shaft has shown a thickness of 56 m.). This capping affects development only in that it is post-mineral and therefore covers any possible outcrops in the area, and that it is very difficult material through which to sink or diamond drill. Throughout the mines narrow basalt dikes, evidently feeders for the capping, are encountered. These affect development only occasionally by minor faulting, and it is probable that they followed post-mineral faults. Mining operations are more affected than development, as the vein walls are soft and broken near the dikes and zones of oxidation extend to either side.

In the El Toro and Clarines mines, large, persistent post-mineral post-basalt rhyolite dikes are found, generally striking roughly parallel to the vein system. In the Clarines mine one of these dikes has followed in part the same line of weakness as the mineralization lying in the hanging wall of the vein for considerable distances.

Faulting—As so far encountered, faulting has been of minor importance as regards development, inasmuch as the throw is generally small and easily determinable. The largest throw known is some 50 m., in the Clarines mine. Faulting does seriously affect mining, determining in many cases the method to be used and the stope length. Most faults are, or have been, watercourses and cause zones of oxidation in the sulphide orebodies down to the lowest levels. There is also a tendency to weak walls near the fault zones, which are particularly troublesome when the faults angle through the orebodies. Fault action has, with few exceptions, been such that the throw is to the right, regardless of the dip of vein or fault.

Mining Operations—These center at three units: the San Francisco, the Clarines, and the El Toro, all ores being shipped by aërial tramway to the mill at the hacienda. The operating centers of the different units lie within 3 to

Table I—Metal Content of Sulphide and Oxide Veins of San Francisco and Clarines Units

Vein	Gold, Gm. Per Metric Ton	Silver, Gm. Per Metric Ton	Lead, %	Copper, %	Zinc, %
San Francisco Sulphides					
San Francisco vein	0.82	239	8.8	0.68	10.6
Footwall vein	0.83	252	7.1	0.50	11.3
East Madroños	1.56	124	5.1	0.36	5.9
Brown vein	0.51	172	7.6	0.74	5.5
West Brown vein	0.58	191	8.8	0.77	9.6
Bronces vein	0.60	200	7.0	1.18	7.8
14-Meter vein	0.92	198	10.1	0.76	9.2
Middle vein	0.63	310	5.8	0.38	8.5
Hill vein	1.64	323	4.9	0.75	8.3
Cobriza vein	0.24	194	7.5	0.79	10.9
Z vein	8.69	212	9.7	1.35	5.5
T vein	1.63	356	8.6	0.44	7.8
X vein	0.50	295	11.5	0.67	10.0
Y vein	2.70	168	7.9	0.31	8.2
San Francisco Oxides					
San Francisco vein	2.59	408	5.4	....	....
East Madroños	2.93	175	5.3	....	....
West Madroños	0.80	259	6.5	....	....
Bronces	2.66	158	2.6	....	....
Hill	1.28	375	5.3	....	....
Brown	0.31	180	13.4	....	....
Y vein	1.80	226	9.3	....	....
Clarines Sulphides					
Clarines vein	0.71	154	4.8	0.95	10.3
Pilares vein	8.4	130	4.0	1.06	7.2
San Carlos vein	2.93	125	4.8	0.85	6.7
Clarines Oxides					
Clarines vein	2.58	152	6.5	....	....
Pilares vein	8.66	91	3.5	....	....

Table II—Proportion of Ore Milled From Various Veins, San Francisco Mine, Sulphide Section

Percentage of Total

Vein	1927–28	1928–29	1929–30	1930–31	1933–34	1934–35
San Francisco	69.5	68.5	70.5	64.5	67.0	34.0
Footwall	21.8	15.2	11.6	8.9	5.9	6.2
East Madroños	4.6	10.4	6.5	5.7	0.1	0.6
Brown	0.6	3.5	8.2	20.5	12.6	19.6
Hill	....	0.9	1.3	0.2	....	1.2
14 Meters	3.2	1.1	1.5	0.1	....	....
Bronces	0.3	0.4	0.2	0.1	8.6	24.8
West Brown	....	....	0.2	....	3.9	6.4
Cobriza	....	....	....	....	1.7	4.6
Z	....	....	....	....	0.1	1.6
T	....	....	....	....	....	0.1
X	....	....	....	....	....	0.6
Frisco	....	....	....	....	....	0.3
Total	100.0	100.0	100.0	100.0	100.0	100.0

Table III—Proportion of Production by Mining Method, San Francisco Mine, Sulphide Section

Percentage of Total

	1928–29	1929–30	1930–31	1933–34	1934–35
Development	5.9	3.1	2.6	6.4	6.2
Hand mining	2.2	2.0	1.9	0.1	....
Shrinkage	34.9	42.9	51.3	48.4	68.3
Bench	57.0	52.0	44.2	34.3	15.7
Cut-and-fill	....	....	....	9.6	9.8
Open overhand	....	....	....	1.2	....
Total	100.0	100.0	100.0	100.0	100.0

Table IV—Levels Opened in North and South Shafts

	North Shaft, Meters	South Shaft, Meters
Collar elevation above sea level	2,140.3	2,173.3
Level 1. Below collar	4.0	35.6
Level 2. Below collar	44.9	....
Tinta level. Below collar	....	....
Level 4. Below collar	108.4	134.6
Level 5. Below collar	158.1	184.8
Level 6. Below collar	208.4	233.6
Level 7. Below collar	258.2	288.1
Level 8. Below collar	308.3	337.5
Level 9. Below collar	357.9	386.5
Level 10. Below collar	418.3	448.6
Sump	558.3	508.6

Table V—Mine Operating Costs Covering a Ten-Year Period

	1925/6	1926/7	1927/8	1928/9	1929/30	1930/1	1931/2	1932/3	1933/4	1934/5	10 Years
Tons milled	205,060	279,330	300,010	307,450	337,480	393,390	98,940		226,470	447,080	2,595,210
Prospecting	$0.07	$0.03	....	....	....	....	....	....	$0.08	$0.05	$0.02
Development	0.53	0.70	$0.75	$0.47	$0.27	$0.17	$0.07	....	0.39	0.31	0.42
Shafts	0.29	0.30	0.18	0.17	0.04	0.06	....	....	0.06	0.11	0.13
Unwatering	0.27	0.22	0.20	0.23	0.14	0.11	0.10	....	0.14	0.09	0.16
Ore breaking	1.27	1.38	0.98	1.27	1.07	0.94	0.66	....	1.07	1.20	1.12
Tramming and hoisting	0.29	0.35	0.39	0.39	0.39	0.36	0.31	....	0.42	0.43	0.38
Aerial tramway	0.08	0.10	0.10	0.10	0.07	0.04	0.03	....	0.05	0.04	0.07
Totals	$2.80	$3.08	$2.60	$2.63	$1.98	$1.68	$1.20	....	$2.21	$2.23	$2.39
Labor	$1.29	$1.36	$1.15	$1.25	$0.88	$0.70	$0.52	....	$0.79	$0.93	$1.00
Supplies	0.86	1.09	0.77	0.79	0.53	0.48	0.23	....	0.80	0.72	0.71
Shops, overhead, miscellaneous	0.44	0.47	0.41	0.32	0.34	0.29	0.26	....	0.37	0.35	0.36
Power	0.21	0.16	0.27	0.27	0.23	0.21	0.19	....	0.25	0.23	0.23
Totals	$2.80	$3.08	$2.60	$2.63	$1.98	$1.68	$1.20	....	$2.21	$2.23	$2.30

Operations were suspended throughout 1932–33 and for nine months in 1931–32 and three months in 1933–34.

8 km. of each other and the hacienda.

Milling operations are on a basis of seven days per week; mining on a basis of six days. Operating on a seven-day milling rate, the different units are on the following production schedule:

San Francisco Unit: 1,100 metric tons per day of sulphide ore, and 250 metric tons of oxide ore. Clarines Unit: 250 metric tons per day of oxide ore. El Toro Unit: Development, shaft sinking, and preparation, the unit to be placed on a 250-ton per day (sulphide ore) schedule in October, 1936.

Operations are classified as follows: Prospecting; shafts; development; ore breaking, including stope preparation; tramming and hoisting; unwatering.

Prospecting—Under this heading is included:

1. Surface work, such as trenching and preliminary shafts and adits. This type of work is done with the double purpose of prospecting surface indications and satisfying the legal requirements for assessment work.

2. Diamond drilling. In 1934 a rather extensive program of long-hole diamond drilling from surface and underground locations was undertaken. Results were not satisfactory, and it seems that this type of prospecting is not adaptable to local conditions. It is costly and does not give definite results.

Drilling from underground locations with short holes has been satisfactory in giving definite information at a reasonable cost. It is believed that underground drilling with holes up to 1,000 ft. long will also prove satisfactory. Two types of drill are in service: the "Prospector" drill, having a capacity of 150 to 250 ft. and used to drill the walls of stopes and drifts for parallel veins, and a larger drill of 1,000-ft. capacity for drilling horizontally across the general strike of the vein system from bases so located as to consider faulting and other geologic features.

Development—This covers all drifting, crosscutting, raising, and winzing which serves to delineate the orebodies for reserve calculations. The amount of such work is planned so that during a year's period the tonnage milled is replaced by newly developed ore. In the San Francisco mine this implies the driving of about 400 lineal meters of drifting monthly; in the Clarines and El Toro mines some 100 m. monthly at each unit.

AN UNDERHAND BENCH STOPE on Level 7 of the Footwall vein of the San Francisco unit. The Mexican machine man is putting down a hole on the edge of the bench

Ore reserves are calculated annually on the basis of fully and partly blocked ore. Ore is considered as fully blocked if it is developed on three sides, and partly blocked if developed on only two sides. Channel-cut samples are used in calculation of grade.

Development at the San Francisco Unit is active on all levels of the South Shaft section from the plus 114 level to Level 10, following the Brown, West Brown, Bronces, Madroños, Hill, X, Y, Z, and T veins. In the North

Table VII—Tramming and Hoisting Costs per Ton Crushed[a]

	Electric Tramming	Hand Tramming	Hoisting
Labor	$0.033	$0.146	$0.037
Supplies	0.016	0.011	0.019
Compressed air	....	....	....
Rock drills and steel	....	....	....
Power	0.003	....	0.026
Shops	0.002	....	0.003
Overhead and miscellaneous	0.013	0.056	0.012
Total	$0.067	$0.213	$0.097

Average tramming distance: Hand tramming, 250 m.; Electric tramming, 600 m.

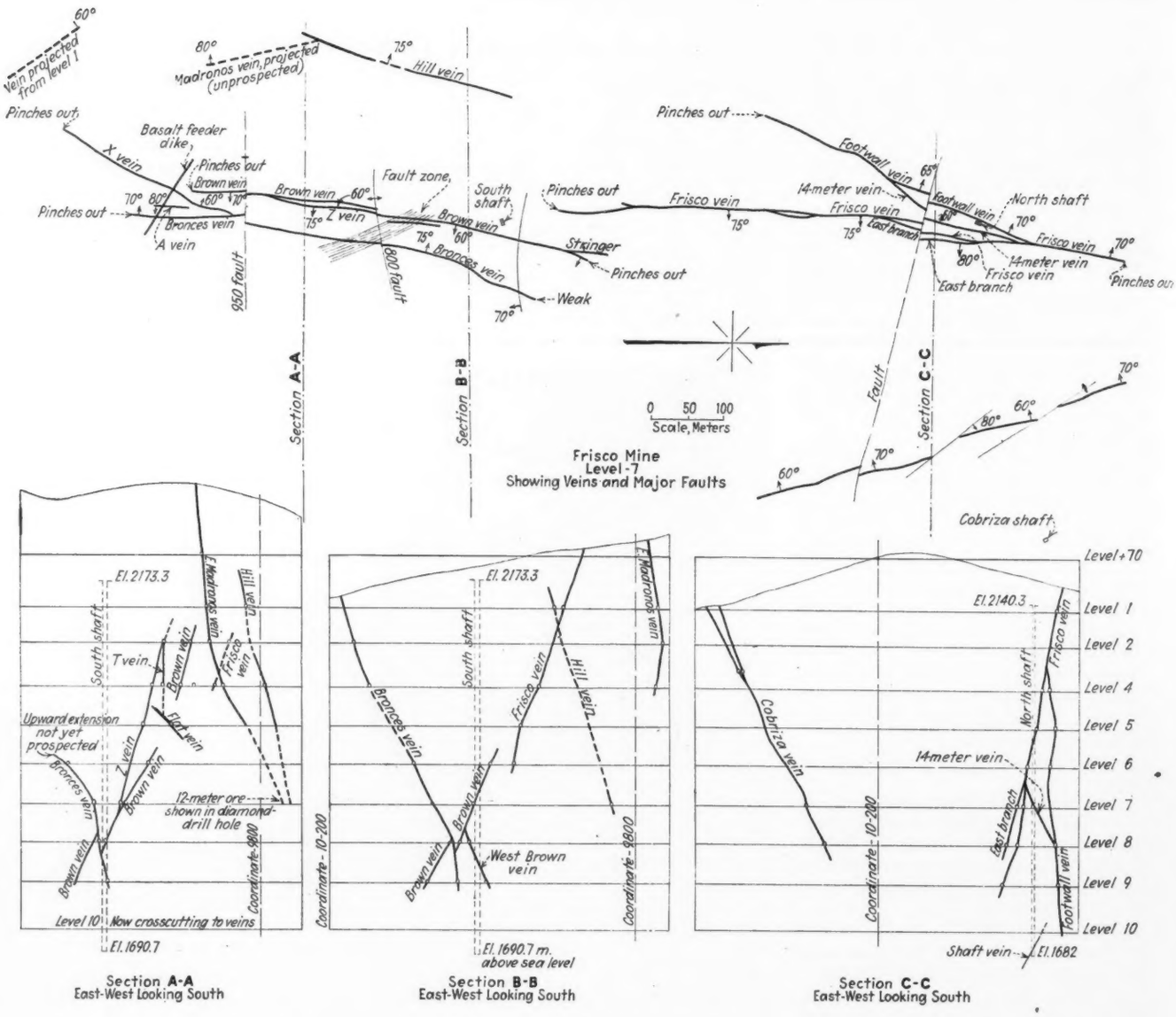
[a] Practically the same as tons hoisted or tons milled.

Table VI—Ore-Breaking Costs, per Ton Broken, Including Stope Preparation and Drawing

	Shrinkage Stoping	Bench Stoping	Cut-and-Fill Stoping
Labor	$0.35	$0.31	$0.68
Supplies	0.32	0.26	0.35
Compressed air	0.17	0.14	0.17
Rock drills and steel	0.18	0.16	0.19
Overhead and miscellaneous	0.16	0.11	0.26
Total	$1.18	$0.98	$1.65

Table VIII—Development and Shaft-Sinking Costs per Meter Driven

	Drifts and Crosscuts	Raises	Winzes	Shafts
Labor	$9.32	$17.50	$45.75	$142.93
Supplies	9.82	11.22	12.87	97.50
Compressed air	3.15	8.08	11.55	18.54
Rock drills and steel	3.33	9.05	10.40	22.01
Power	....	....	....	2.08
Shops	....	....	0.22	3.41
Overhead and miscellaneous	3.17	6.95	12.00	9.73
Total	$28.79	$52.80	$92.79	$296.20



OREBODIES of the San Francisco Mines of Mexico occur as fissure veins in flatly dipping calcareous shales. The veins strike for the most part almost north-south. Vein filling is mostly quartz, with calcite and fluorite. The above cut shows the veins and major faults of the San Francisco mine in plan view and three sections. Locally, the official name "San Francisco" for mine and vein is shortened to "Frisco"

Shaft section development is confined to the Cobriza vein from the fourth to the seventh level. A development of probable major importance is the "Farthest South" drift on Level 7, which will be pushed out of the San Francisco and into the Granadeña area and will serve as a base for diamond drilling east and west across the fracture system. Plans are also being made to sink a standard three-compartment shaft about 1,000 m. south of the South Shaft. This is to reach the seventh level horizon and ultimately connect with the "Farthest South" drift.

Development at the Clarines Unit is active in both the oxide and sulphide sections, following the Clarines, Pilares, and San Carlos veins.

At the El Toro Unit the Favorita and Garabatos veins are being developed. Before this unit can be put into production, the La Mesa shaft will have to be sunk 290 m. and equipped as a main hoisting shaft, with pockets and stations on the Toro and 60 levels; the San Jose shaft will have to be enlarged to standard 5x16-ft. size and sunk to the 120 level; and the Toro tunnel must be enlarged and the grade corrected for motor haulage.

Up to 1932, production was mainly from the San Francisco vein, the smaller veins being called on for only minor tonnages. The San Francisco vein was ideal in many ways: it was of good grade and uniform in mineral ratio; it had good walls, with vein widths varying from 2 to 8 m. and averaging roughly 5 m.; faulting and oxidation were of minor importance, and haulage problems were minimized by its relationship to the North and South shafts. When operations were suspended in 1932, because of low metal prices, the vein was well on its way to exhaustion. Operations were resumed in January, 1934, and the major problem was to replace San Francisco tonnage with tonnage from other veins. Development and mining of these veins presented different problems in the mine as well as the mill, calling for an increase in development footage, changes in the mining method, and spreading of operations over a large area.

The change in production sources, mining methods, and development areas is shown in Table II.

Ore Breaking—At the San Francisco Unit, shrinkage, underhand benching, and cut-and-fill stoping methods are used in the sulphide section. In the oxide section all ore is stoped by shrinkage. At the Clarines Unit shrinkage and cut-and-fill methods are used.

Stope preparation covering chute raises, stope raises, and intermediate drifts calls for some 350 lineal meters

per month in the San Francisco mine and 100 m. in the Clarines. The cost of this work is considered as a part of that of ore breaking.

In shrinkage stoping, solid pillars are left above and below the levels, to be mined at a later period. The pillars are from 2 to 5 m. thick, depending on the physical condition of the orebody. Chutes are put up at 10-m. intervals. Stope lengths vary from 50 to 250 m., the length usually determined by faulting. In general, stopes are carried with one connection to this level above (usually at one end of the stope) and cribbed or lagged manways from the level below at 50-m. intervals. Stopes 2 m. wide or better are carried as breast stopes with rill back, using 3½-in. mounted machines, with cuts averaging 6 ft. Larger cuts were used at one time, but it was found that this system caused high dilution and a heavy charge for secondary breaking. It also slowed up the pull and made cleaning down of the stope difficult and expensive.

In the narrower veins and in the oxide sections hand-rotated or automatic stoper machines are used and the stope is carried with a flat back. In the oxide section of the mines, stopes are carried much shorter than in the sulphide sections, so that they can be finished and pulled before the ore cements and before the walls loosen sufficiently to cause excessive dilution. The breast stope with rill back is preferable whenever possible, as it gives a better breaking cost and ties up the broken ore for a shorter period. In general, it is planned to carry approximately a three months' supply of broken ore in stopes.

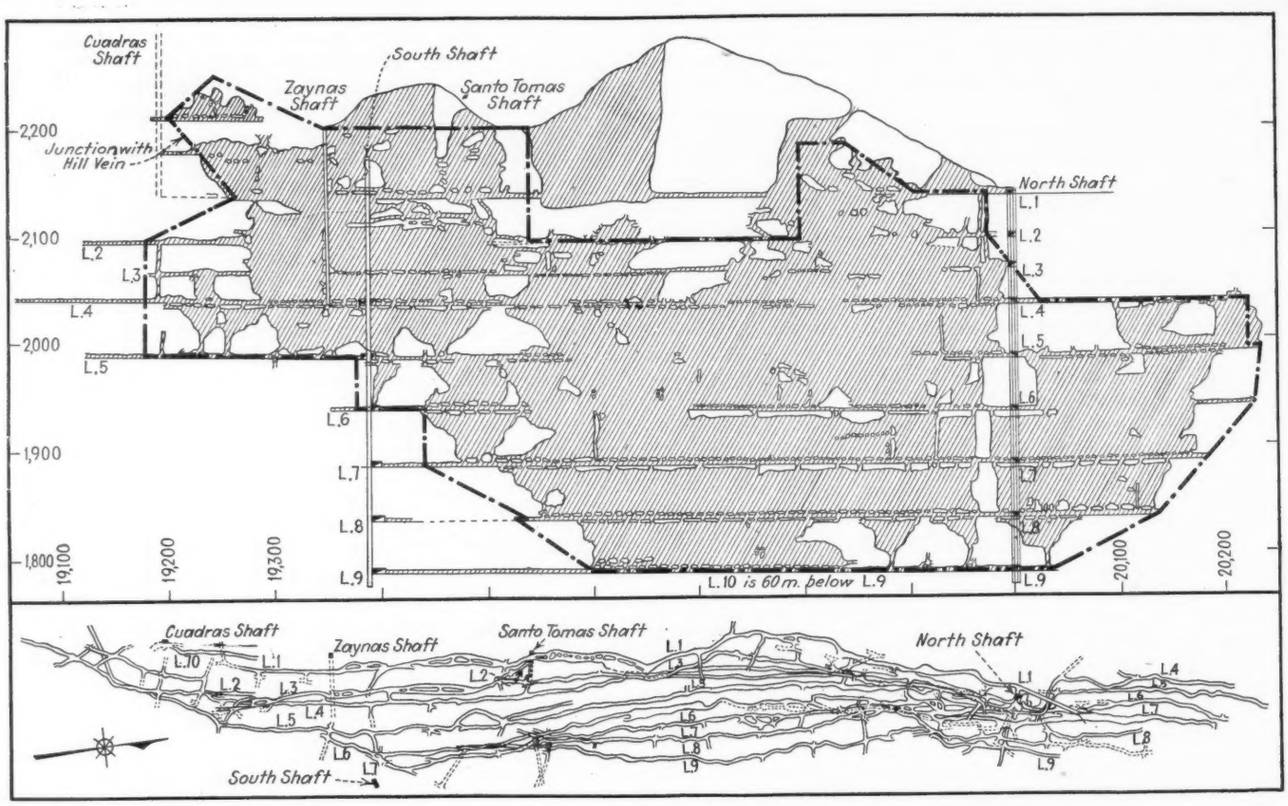
Underhand bench stoping is usually used to finish up the corners in shrinkage stopes and elsewhere where conditions make this method of stoping advisable. Stoping is done with hand-held sinker-type drills of 65-lb. weight. Two to three benches are usually carried. In general, three shifts are worked in bench stopes—two shifts drilling and one shift mucking off the benches.

Cut-and-fill stoping is used where faulting and vein intersections make this type of stope necessary. In the San Francisco Unit the stopes are long—better than 100 m.—and are carried in three sections—one section breaking ore, one section mucking ore, and one section filling. Drilling is done with 3½-in. mounted machines making a 10- to 15-ft. cut. Ore is not generally broken down on flooring, as the time elapsed between completion of the fill and breaking is sufficient to pack the fill so that loss of ore or dilution is inconsiderable. Fill is obtained from development headings and from the surface. In the Clarines Unit, breaking is done with automatic rotated stopers and the ore is broken on 3-in. plank flooring. In both mines fill is moved by double-drum, 7½-hp., air-operated slushing hoists and ore is hand-mucked and moved by wheelbarrow to the ore chutes.

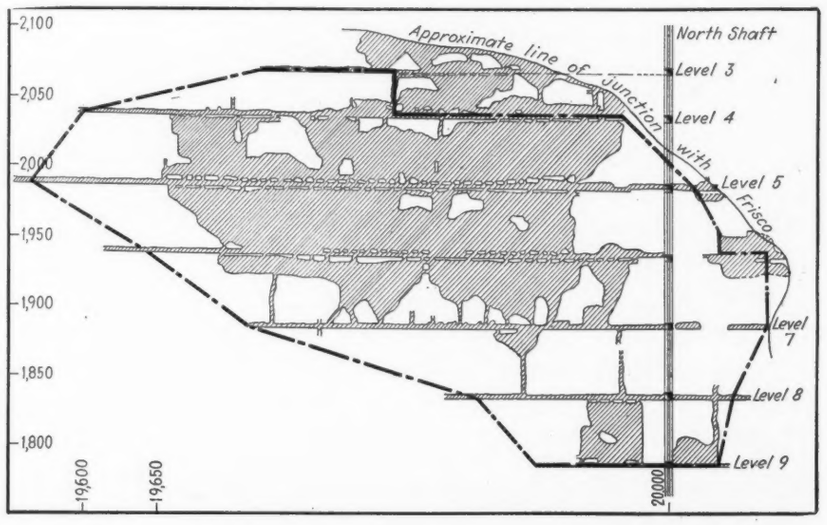
Rock Drills—All drilling is done wet.

LOOKING DOWN ON THE REMEDIOS SHAFT

and the surface plant of the Clarines unit from the outcrop of the Clarines vein. At the left on a line with the crushing plant may be seen the outcrop of the Pilares vein. The housed conveyor ascends to the tramway bins.



THE SAN FRANCISCO VEIN, the mine workings on which are here depicted in longitudinal plan and vertical projection, shows economic mineralization over a vertical range of 480 meters, or from the surface outcrop to Level 9, at which elevation the oreshoot has shortened considerably, values have decreased markedly, and the vein filling has become siliceous. Level 10 is under development. The dot-dash line incloses the ore reserves.



"FOOTWALL" VEIN workings of the San Francisco mine are here shown in longitudinal vertical projection. As in the case of the San Francisco vein, the vein filling is turning siliceous with depth and the length of oreshoot shortening, suggesting vertical limitation of economic mineralization here also. This, however, is yet to be proved.

Various types and makes of machines are used, but in general the following may be said: 3½-in. mounted machines using 1¼-in. round lugged steel are used in crosscutting, drifting, stope preparation, and breast stopes. Drills are mounted on single- or double-screw 3½-in. columns.

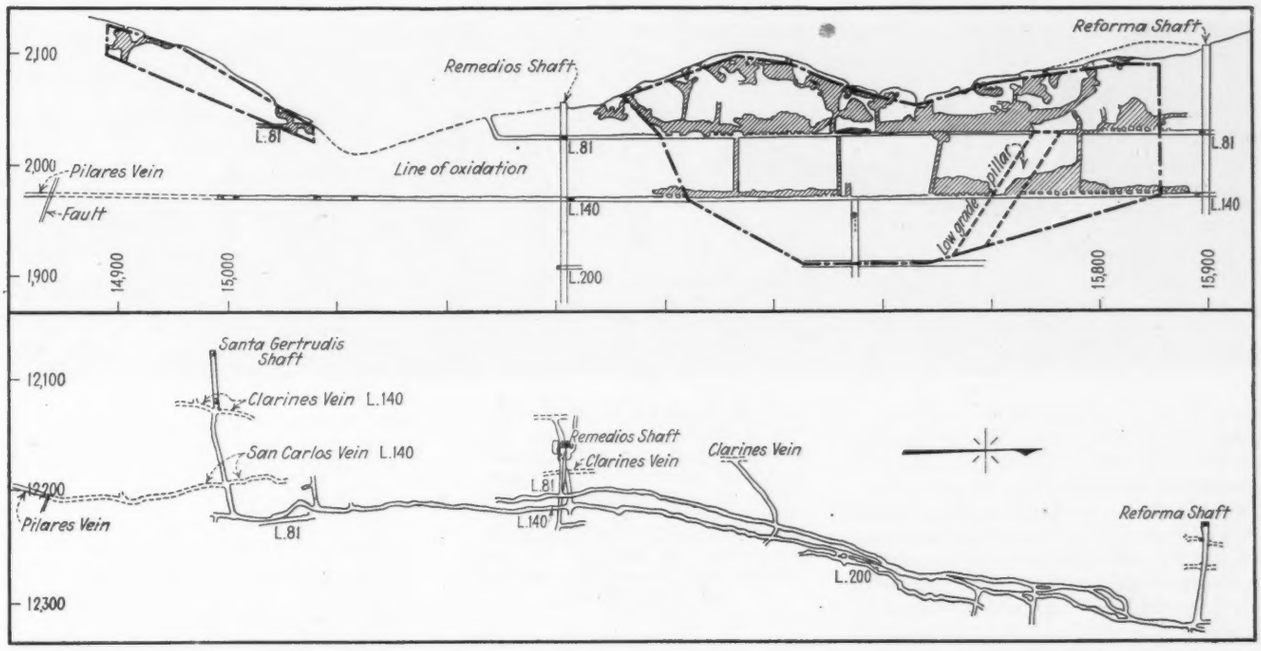
Hand- or automatically-rotated stopers are used in raises and stopes, automatic stopers using 1¼-in. round lugged steel and hand-rotated machines using 1-in. quarter-octagon steel with straight shank.

Hand-held sinkers, from 45 to 75 lb. in weight and using 1-in. quarter-octagon steel with collared shank, are used in bench stopes, winzes, and shafts. Hitches for timber are cut with light, sinker-type drills with the rotation removed.

Drill Steel—In the San Francisco mine both standard forged steel and detachable bits are used. The Clarines and El Toro units use detachable bits exclusively. With drifting machines and automatic stopers 1¼-in. round steel is used; 1-in. quarter-octagon steel is used with sinkers and hand-rotated stopers.

Detachable bits are issued to the contractors or machine men on the surface and carried by them on the cages and to their working places. Drill rods are handled in the same way. The ground in general is hard, and each machine is allowed four sets of rods. Records are kept showing bits and rods issued to and returned by each contractor.

The use of detachable bits is still in the experimental or trial stage, and considerable pioneer work remains yet to be done, chiefly in the tempering of reground bits and prevention of excessive rod breakage and thread wear. It seems probable that their use will be found more economical (and certainly more convenient), chiefly because of the saving in labor after the steel gets underground and the saving in hoisting time required to handle standard steel. Inasmuch as the San Francisco mine would require some 3,000 pieces of steel per day, there is the possibility of a considerable saving in these two items. All



types of detachable bits have been used, and it has been found that to be considered economically a bit must run more than three times; that is, it must be reground at least three times. Because of the hardness of the rock in all of the company mines, bits must be retempered after the first regrind. A new bit will generally run two to three times as far as a forged bit, and if regrinds are properly tempered they should do almost as well; however, there is always a loss, and as a general average it is considered that a bit which has run three times has performed five times the work of a forged bit.

Rod breakage and thread wear constitute about as big a problem as the bits themselves. Over a considerable time the San Francisco mine has shown that, due to breakage or thread wear, a new rod is required for every 18.7 bits used; the Clarines Unit shows one rod is needed for every 13.9 bits used, the difference being due to the different types of bits used at the two units. Certain local conditions such as the large tonnage of steel necessary because of hard ground, the problem of transporting steel from a central shop or placing shops at each unit, and the handling problem once the steel is underground, as well as the hoisting time used in raising and lowering steel, warrant the pioneering work now being done to determine the possibilities that detachable bits have to offer.

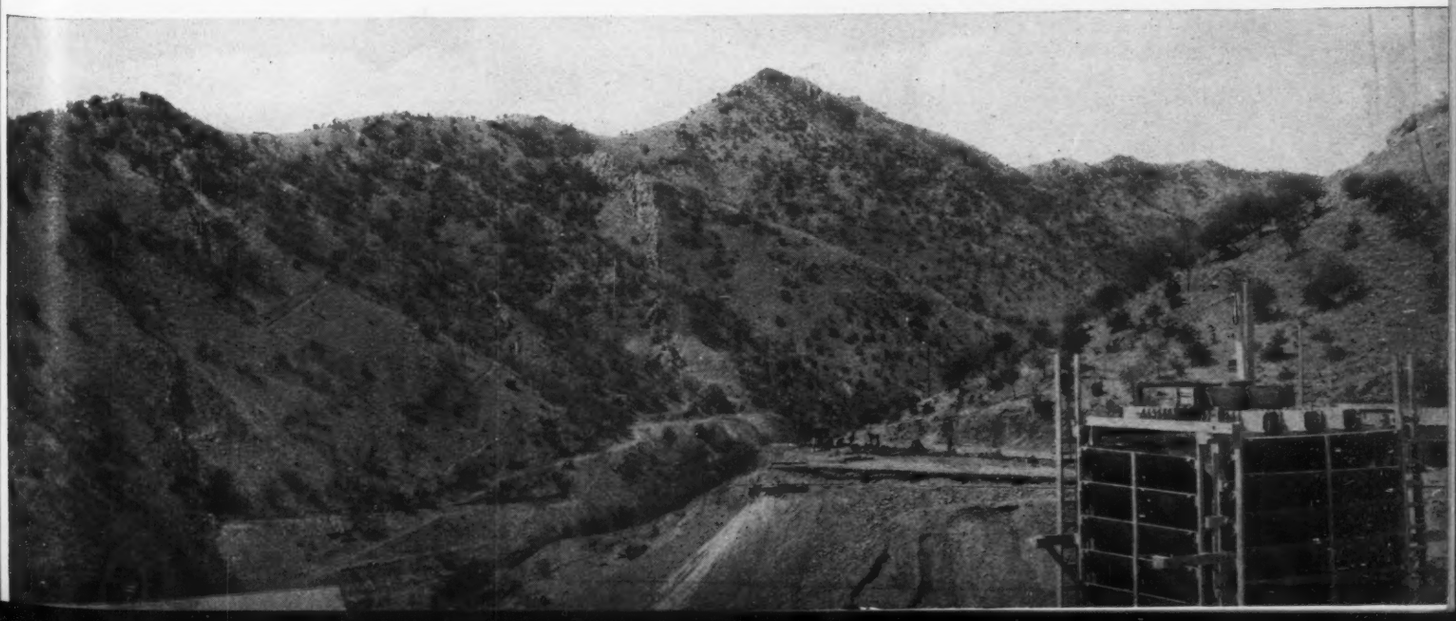
THE PILARES VEIN, in the Clarines Unit, has shown an average metal content of 8.4 grams of gold per ton, 130 grams of silver, 4 per cent lead, 1.06 per cent copper and 7.2 per cent zinc. It has been opened on three levels, the workings here being seen in longitudinal plan and vertical projection

Explosives—Powder and cap magazines are located where necessary underground, there being ten such pairs in the San Francisco mine. Sixty and 40 per cent gelatine dynamites are used. Semigelatines have been tried, and though they are effective as far as blasting is concerned, the fumes produced and the crumbly nature of the explosives have made their use inadvisable.

Blasting in general is done with 1⅛x8-in. cartridges using triple-tape fuse and No. 6 caps. Electric blasting is used in raises, winzes, and shafts and is being tried out for shooting cut holes in drift rounds. Stemming and spacers are not in general use in the San Francisco mine, but are employed with satisfactory results in the Clarines mine.

In the San Francisco mine blasting is generally done by the contractors and machine men, each shift blasting its own holes. The Clarines mine is using a blasting crew and blasting all holes on the third shift.

Tramming and Hoisting: The San Francisco Unit—The mine is operated



OUTCROPS OF VEINS of the Clarines Unit are clearly recognizable on the hillside in the left half of the picture. At the left are the faulted sections of the Pilares vein. In the center is the Clarines outcrop and, less distinct, between the two that of the San Carlos

"EL RANCHITO," or El Ranchito San Lorenzo, as the place was known when it was used as a summer home by one of the early governors of Northern Mexico, who enjoyed the title of "Vic Rey de Noeva Visquaia." Today the building serves as hospital for the Clarines Unit and as living quarters for staff members

through two vertical 5x16-ft., three-compartment shafts: the North Shaft and the South Shaft. The Cobriza shaft, recently completed to service the Cobriza vein, is a 5x13-ft. incline sunk 290 m. on the vein (from the outcrop to Level 7), which is used as a manway, an ore pass, and for ventilation. All ore mined in the Cobriza section will be trammed on levels 7 and 8 to the North Shaft and hoisted. The North and South shafts lie some 600 m. apart, being spotted along the general strike of the San Francisco vein. At present operations are carried on on all levels from a point 300 m. north of the North Shaft to a point 700 m. south of the South Shaft, or 1,600 m. along the strike of the vein system. Normal to the line connecting the North and South shafts, operations cover some 600 m. Both shafts are equipped, and used, for hoisting ore and hoisting and lowering men and material. Hoisting is done in balance with 3-ton skips hung over two-deck cages.

From these two shafts levels are opened as shown in Table IV, p. 382. The shafts are interconnected on levels 1, 7, 8, and 9, and before the level pillars on the San Francisco vein were removed were connected on levels 4, 5, and 6.

Inasmuch as the shafts are in hard shale, no timbering is necessary other than that required to support the guides. Both shafts were timbered with standard wooden sets when they were driven and the South Shaft still retains its original timber. .

During the suspension of operations from 1932 to 1934, the wooden sets were removed from the North Shaft and replaced with steel. At the same shaft all levels from Level 5 down are provided with ore pockets of 300 to 1,000 metric tons' capacity and waste pockets of 100 to 300 tons' capacity; at the South Shaft ore pockets of 200 to 500 tons' capacity are located at levels 5, 6, 7, and 8. Pockets at both shafts are equipped with 14-in. flat grizzlies made from 65-lb. rail and set 3 ft. below the track level.

Ore is trammed to the shaft pockets by hand in 19-cu.ft. end-dump cars or by storage-battery locomotive of the Mancha type in 19-cu.ft. end- or side-dump cars or 32-cu.ft. rocker-bottom cars. All cars are 18 in. in gage and equipped with roller bearings. Track grades are run at 0.5 per cent in favor of the load; and 16- or 25-lb. rail is used. Level 1 between the North Shaft and the South Shaft can be considered as a main haulage level in that all ore hoisted through the South Shaft is trammed on this level to the tramway bins at the North Shaft. This level is equipped with two 3-ton storage-battery locomotives and 32-cu.ft. rocker-bottom cars.

Sulphide ore moves as follows:

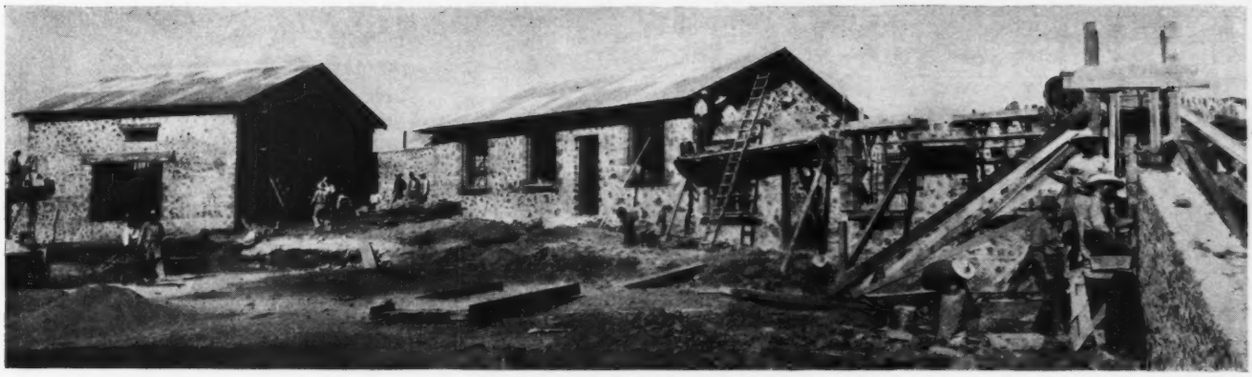
1. Ore tributary to the North Shaft is trammed by hand or motor to the shaft pockets on each level and hoisted to the surface. From the shaft bins it is fed by belt conveyor to a gyratory crusher, crushed to 3½-in. size, and dropped directly into the tramway bins above the Tinta level, these bins having a capacity of approximately 1,500 tons.

2. Ore tributary to the South Shaft is trammed by hand or motor to the shaft pockets and hoisted to the surface. From the shaft bins it is fed by a slow-moving belt conveyor serving also as a sorting belt, to a jaw crusher, crushed to 3½-in. size, and dropped directly into a 600-ton storage bin above Level 1. From this bin it is trammed 720 m. by 3-ton storage-battery locomotives to the tramway storage bins at the North Shaft.

3. In general, ore pulled on any one level is trammed to the shaft pockets on that level; however, to provide for trouble in either the South Shaft or Level 1 haulage, all ore tributary to the South Shaft can be bypassed through transfer chutes to Level 9, trammed by motor on that level to the North Shaft, and hoisted. Inasmuch as some 86 per cent of the sulphide tonnage hoisted is tributary to the South Shaft, it is necessary that this flow of ore be protected.

At present, all oxide ore is mined on

AN ADOBE WALL surrounds the buildings at the North Shaft of the San Francisco mine. At the right are the headframe, hoist building, and machine shop. In the center foreground the small building with the picket gates stands over the portal of the No. 1 haulage level, from which has just emerged the train of cars standing further to the left, where the storage-battery locomotive is being recharged



AT EL TORO UNIT construction is here seen nearing completion. The building at the right will house the "almacen," or warehouse, and the pay office; that in the middle the office, and the one at the left the new 225-hp. hoist. A 10-ft. stone wall surrounds the site of surface operations. Mexican masons at the right are finishing the work on this around the main gate

Level 1 or above and in the area tributary to the South Shaft. All ore pulled on sublevels above Level 1 is transferred to that level and along with such ore as is pulled on Level 1 is dropped through old stopes to Level 4. On Level 4 it is hand-trammed to a pocket directly connected with the Level 5 hoisting pocket, hoisted from this level to the surface, crushed and dropped directly into a 600-ton storage bin above Level 1, and from there trammed by 3-ton storage-battery locomotive to the oxide tramway bins above the Tinta level at the North Shaft. These bins have a capacity of 1,500 tons. A counter-drift is being run to connect the North and South shafts on Level 5, and when this is completed oxide ore can be trammed to the North Shaft on that level, should this be necessary or advisable. There will then be two different and independent methods of getting South Shaft ore to the tramway bins.

Tramming and Hoisting: Clarines Unit—The mine is operated through two vertical three-compartment (5x15-ft.) shafts: the Remedios and the Reforma. These lie 600 m. apart, being located along the general strike of the Pilares-Clarines vein system. At present, operations are carried on through the 81, 140, and 200 levels from a point 200 m. north of the Reforma shaft to a point 500 m. south of the Remedios shaft (or 1,300 m. along the strike of the vein system). Normal to the strike, operations cover a distance of 200 m.

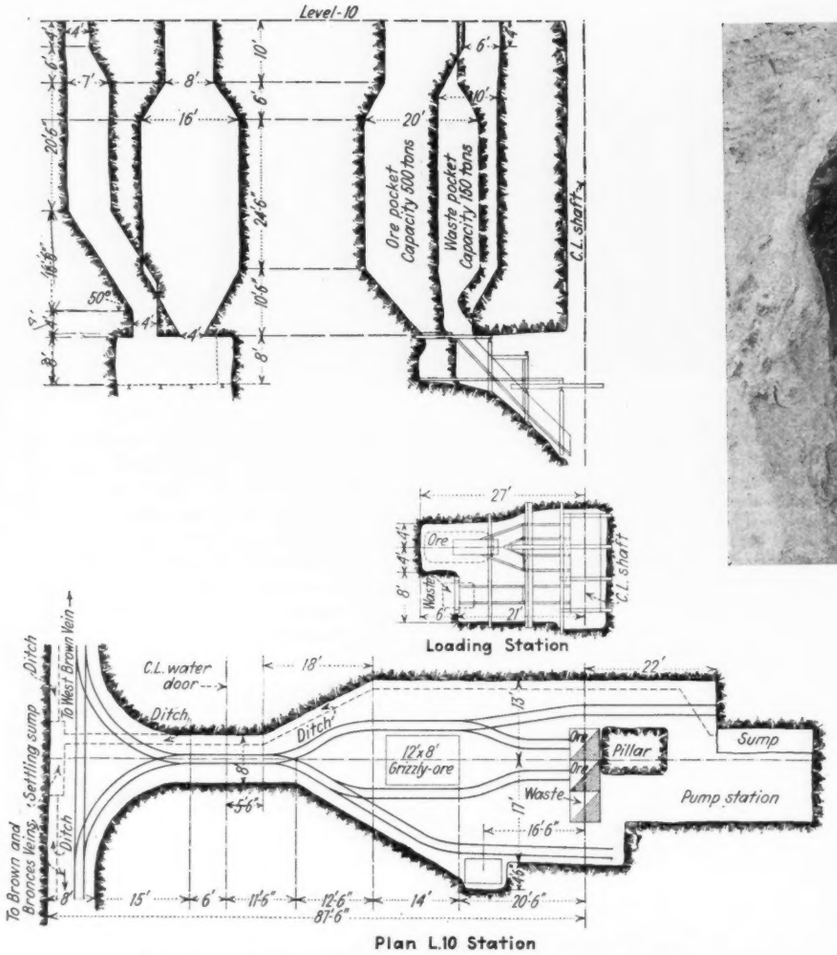
The Reforma shaft (collar, 2,106.2 m. above sea level) has reached a depth of 134.5 m., with levels opened as follows: 50 level, 52.7 m.; 81 level, 83.1 m.; and 140 level, 134.7 m. The shaft is used for hoisting and lowering men and material and has single-deck cages hoisting in balance. No ore is hoisted in this shaft. Timbering is partly of steel and partly of standard wooden sets.

The Remedios shaft (collar elevation 2,055.0 m. above sea level) has reached a depth of 188.5 m. Levels have been opened as follows: 81 level, 31.8 m.; 140 level, 88.4 m.; and 200 level, 148.5 m. The shaft is equipped with 3-ton skips hoisting in balance and is used solely for hoisting ore, except that men are raised and lowered between the 140 and 200 levels. The 140 and 200 levels have each two 300-ton pockets which can be used for sulphide or oxide ore or waste. The pocket and loading arrangement are the same as used at the San Francisco Unit. The shaft is in hard slate, and timber is unnecessary except for holding guides. Timbering is partly of wooden sets and partly of steel.

All ore broken above the 81 level is hand-trammed to transfer raises discharging on the 140 level. On the latter, ore is trammed by hand to the shaft pockets, hoisted to surface, fed from the shaft bin to a slow-moving belt conveyor (which serves as a sorting belt), then to a gyratory crusher, crushed to 3½-in. size, and elevated to the tramway bins. The 200 level is just being opened up, and, when opened, all ore mined between it and the 140 will be trammed to the shaft pockets on this level and hoisted.

All tramming is done by hand, using 19-cu.ft. end-dump cars. Grades are run 0.5 per cent in favor of the load; track is of 16-lb. rail at 18-in. gage.

El Toro Unit—This unit will be operated through the La Mesa and San Jose shafts. Here the shafts are laid out differently than at the San Francisco and Clarines units, in that instead of



LEVEL 10 STATION of the South Shaft of the San Francisco Mine and the loading station below it, both in plan. Also the loading pockets for ore and waste, in two views. The South Shaft bottoms 60 meters below Level 10

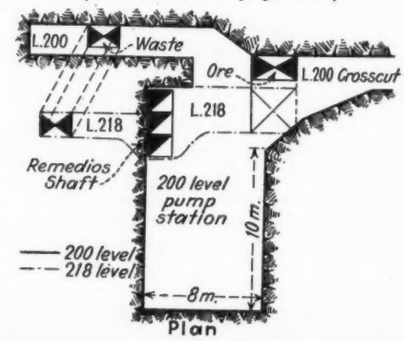
AN UNDERGROUND SHRINE
In this short heading just off the main ore haulageway in the San Francisco mine stands this small wooden cross, adorned with artificial flowers, beads, colored paper, and miniatures. The fresh candle indicates the beginning of a new shift, as candles left earlier in the day have burned out. Many miners place a candle and say a prayer before starting their day's work

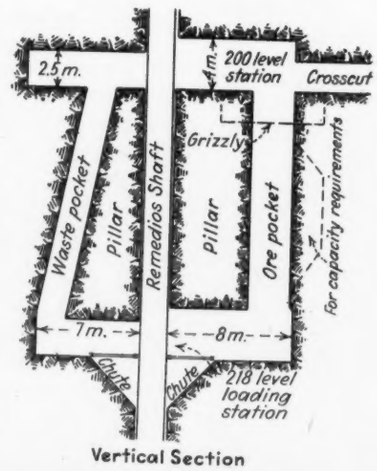
being located along the vein system they are placed across the vein system. The La Mesa shaft will develop and serve one series of veins; the San Jose shaft, another. The shafts are 920 m. apart and will be interconnected only on the El Toro tunnel level. The La Mesa shaft will be equipped for skip hoisting with a 3-ton skip hung over double-deck cages and hoisting in balance. Pocket and loading arrangement will be the same as at the San Francisco Unit. The San Jose shaft will use double-deck cages hoisting in balance, and all ore tributary to it will be hoisted on cages in cars to the El Toro level and on that level trammed by trolley locomotion to the La Mesa shaft, dumped in pockets, and hoisted to the surface, where it will be crushed and conveyed by belt conveyor to the tramway bins. Both shafts will be of the three-compartment cross-section used elsewhere.

Working Practice—Whenever possible work is done on a contract basis, the men being guaranteed the minimum wage corresponding to their classification, and any earnings over their wages are divided (by the company) in proportion to the wages earned. Contracts are for labor only.

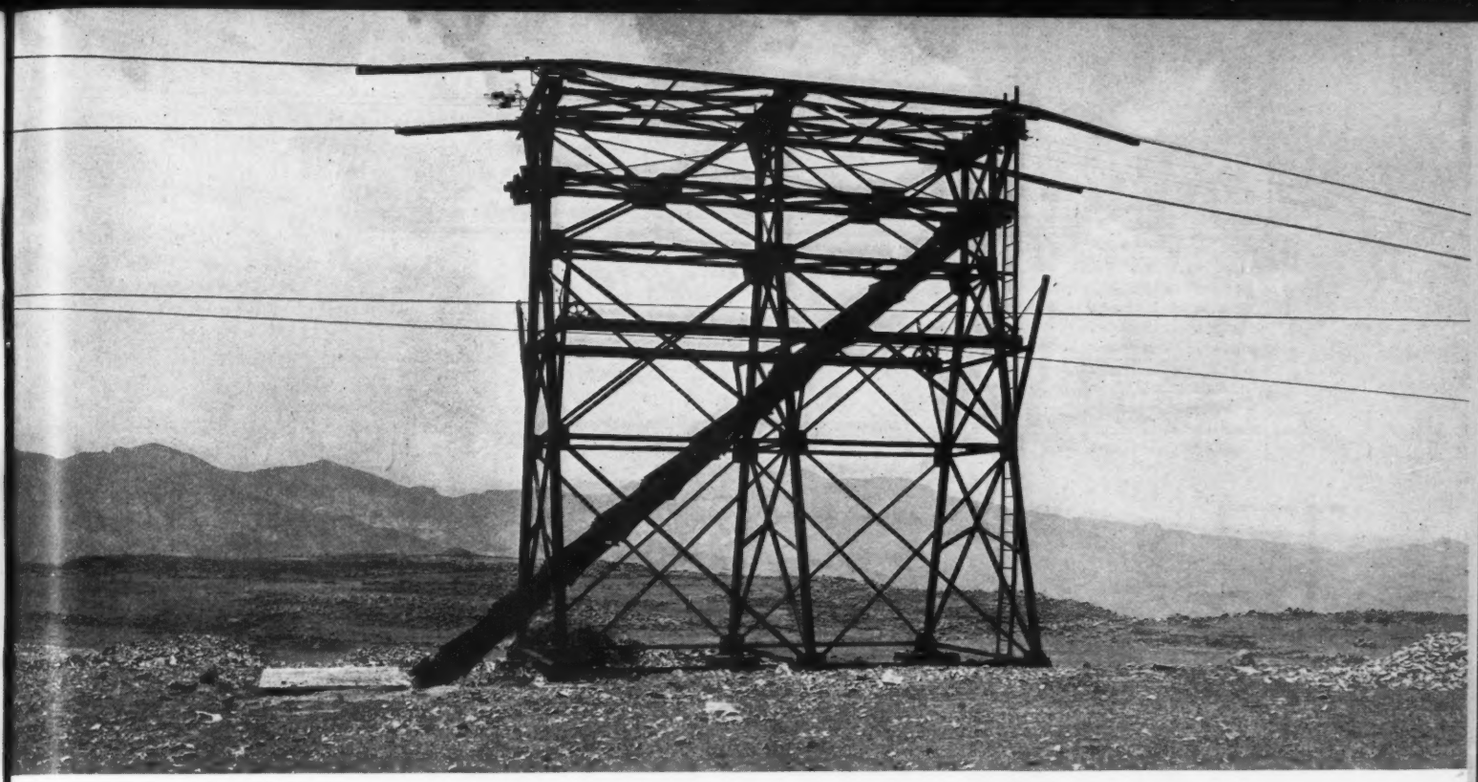
Drifts and crosscuts are driven 6x8 ft. in cross-section, and with a machine man and helper, where detachable bits are used; if standard steel is used, a nipper is added to the crew. In the sulphide section an average round is drilled with 18 to 22 holes, using a pyramid cut, and is blasted with 130 to 150 sticks of 60 per cent gelatine. Sixty to 130 pieces of steel or 30 to 60 detachable bits are needed. Work accomplished varies greatly with the individual contractors, ranging from 2½ to 6 ft. advance per drill shift, with an average of 2.8 ft. per drill shift or 5.0 ft. per round blasted. If a drainage ditch is necessary, it is cut separately from the work of driving of the drift. Because of the contract system in force under terms of the collective contract with the workmen, breakage in the stopes is not as good as it should be, running from 5 tons per machine shift in stopes under 1.5 m. wide to 20 tons per machine shift in the wider stopes.

(*Continued on page 396*)





ORE AND WASTE POCKETS
as planned, below Level 200 station of the Remedios shaft of the Clarines mine, in two views. This shaft has reached a depth of 188.5 m. It is equipped with balanced 3-ton skips and is used solely for hoisting ore, save that men are carried between levels 140 and 200



SILHOUETTED against sky and mountain, this tramway tower marks the highest elevation between Clarines and the mill. It rests at 7,706 ft. above sea level and supports four long strands of cable. A steel diagonal brace gives additional support because of a steep downgrade to Clarines, which is about 6,000 ft. to the left

Wire-rope Transport System Unique

Three Circuits Carry Ore—One Is Loaded and Runs Underground for 3,000 ft.

W. G. Campbell
Superintendent of Tramway

THE present aërial tramway is the third that has been in operation between San Francisco and the mill. The first one, built at a date unknown, but operated until 1906, extended from the mine to the original hacienda located on what is now the site of the foreign colony known as San Antonio. Of it we have no information except that there was one on that site and the capacity was 300 tons in 24 hours.

In 1911, construction was started on a mill on the present millsite, and also on the second tramway from the mine to the new mill. Previously, from 1906 to 1911, the property had no hacienda or mill, all ores (oxidized) being sorted and hauled on burros from the mine to the shipping point.

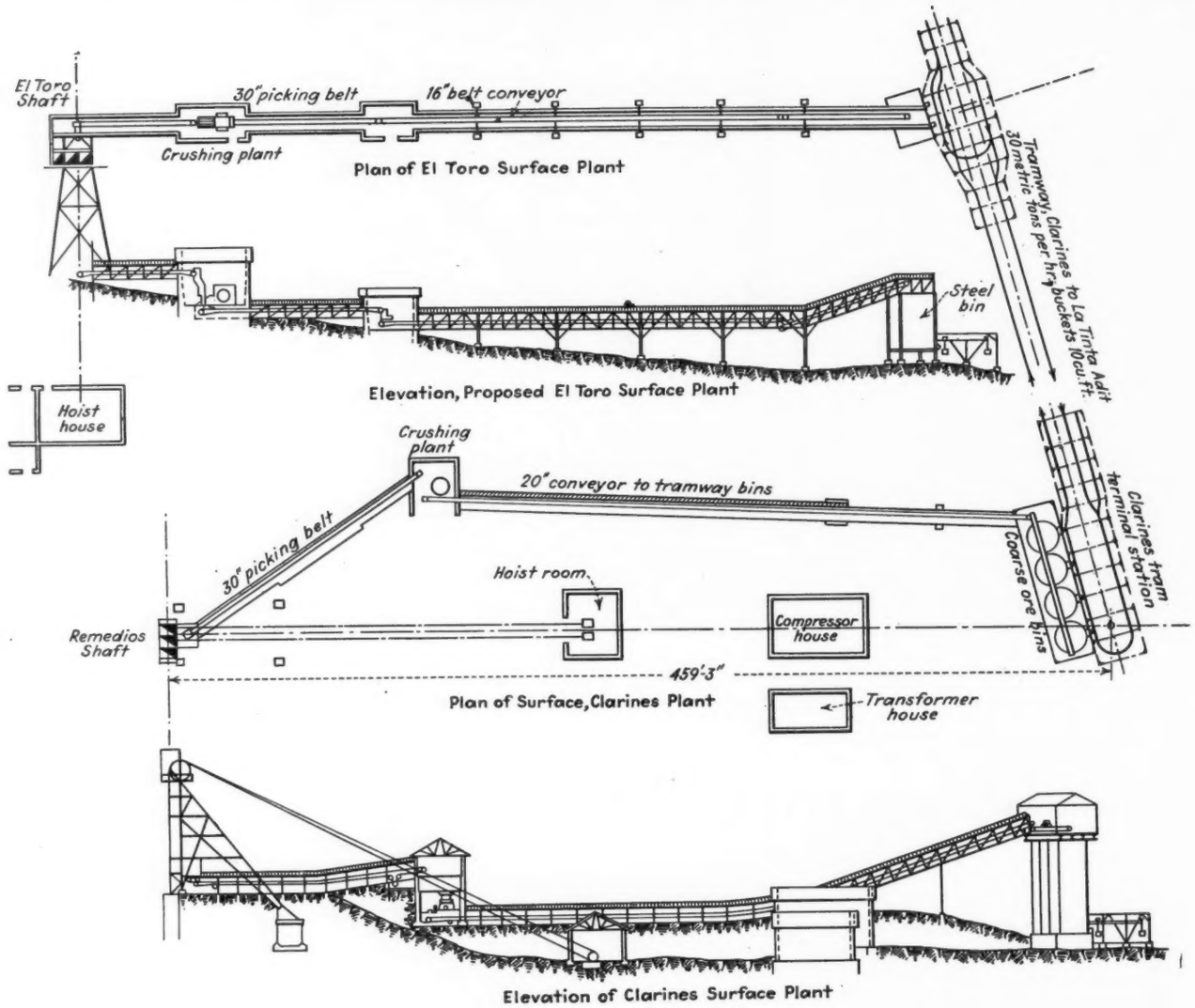
The second tramway was constructed by the Bauson-Lescher Company. It was built entirely of wood, both terminals, with bins and towers, being of that material. It had a stationary track of $1\frac{1}{2}$-in. lock-coil cable on the load side and $\frac{7}{8}$-in. on the empty, and a $\frac{5}{8}$-in. Lang lay traveling traction rope. The capacity was 500 tons per 24 hours with buckets having a 550-kg. capacity of sulphide ore.

In 1927, as tonnage was to be increased, additional towers were built along the tram, and the capacity was increased to 800 tons. In 1931, the amount of ore transported had reached 1,100 tons in 24 hours.

As early as 1929, plans were being studied for the construction of an oxide mill unit and another for the treatment of oxide ores from the Clarines mine. This would require more tramway capacity. After thorough investigation and estimations, it was decided to drive an adit from the San Francisco del Oro arroyo to the North Shaft, a distance of 930 m. The elevation of this adit at the San Francisco shaft was about 17 m. above Level 4, and 90 m. below the collar of the shaft. This would give a large storage capacity at the mine for the different types of ores, as old stopes could be used as ore bins.

This adit was to be large enough in cross-section to permit the tramway to enter and load at the shaft. No comparable operating problem was known, so the company pioneered in this type of undertaking, the outcome of which has proved highly satisfactory. The adit, called La Tinta, was driven with a cross-section of 3.5 m. high by 4 m. wide.

While the adit was being driven, fabrication of the steel for the tramway from La Tinta to the hacienda was done at the company shops, starting in March, 1934. In one week, foundations for two towers were made, and the work was maintained at this rate until all foundations were completed. As soon as foundations were ready the steel towers were erected, and this unit of the tramway, from the angle station to the hacienda, started operating in December. Seventy men were used in laying out and erecting towers, under the supervision of an engineer supplied by the American Steel & Wire Company, which designed the tramway. About 190 tons of steel was used in the San Francisco tramway and 270 tons in the Clarines. Following completion of the San Francisco section of the tramway, the one to Clarines was started, and it was completed in April, 1935.



CONVEYOR SYSTEMS at Clarines and El Toro units for carrying ore to their respective tramway terminals. These facilities are already in use at Clarines and are about to be installed at El Toro.

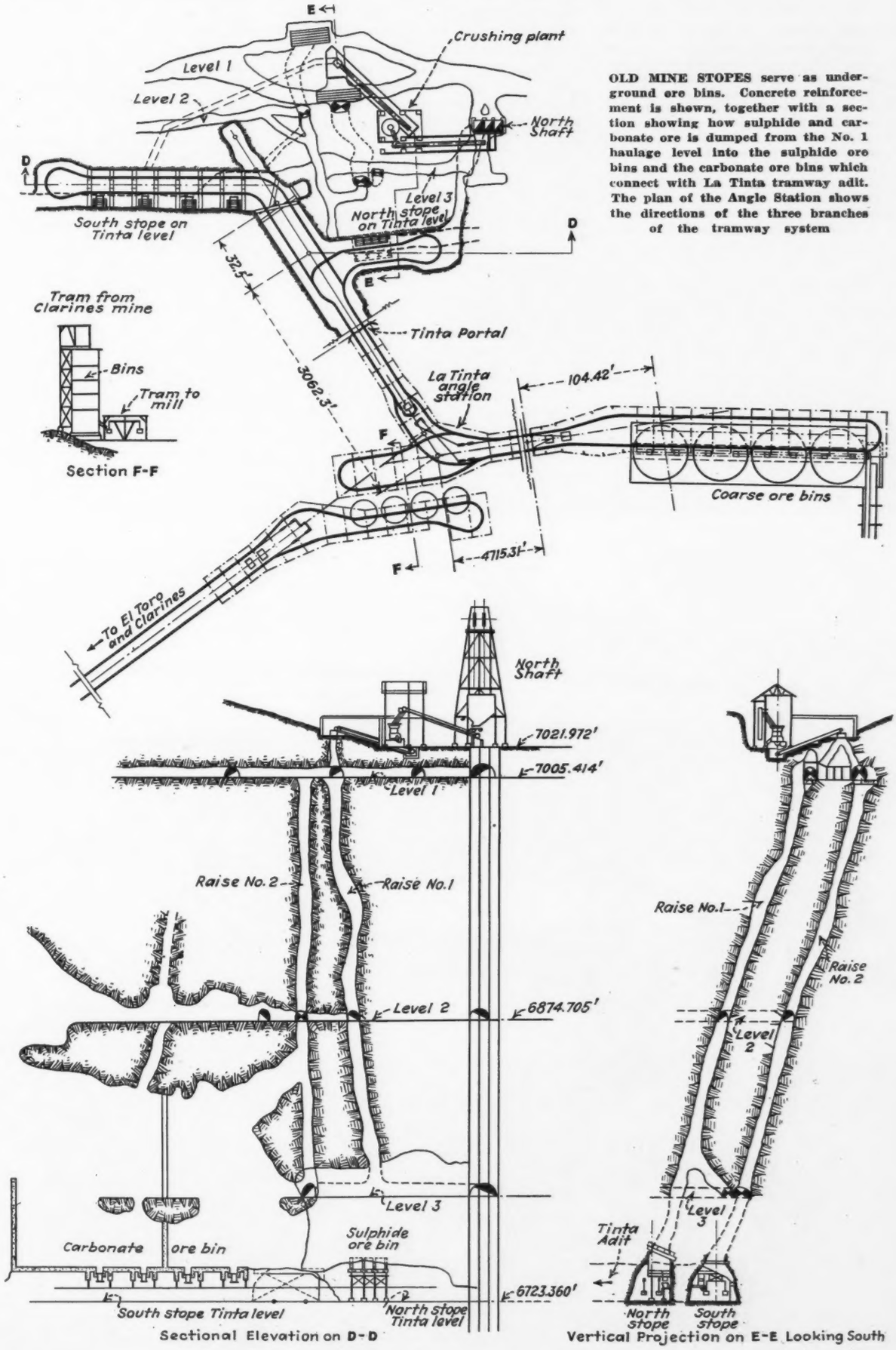
The bottoms of the old stopes were caught up with reinforced concrete and divided into bins for different ores. The two underground loading stations are not on the same straight line, due to fault conditions in the shale. In the south loading station for sulphides, the ore is loaded into buckets through five hand-operated undercut bin gates. The rail structure in this station is suspended from the bottom of the bin, whereas in the north stope the rail structure is supported from the floor. Buckets are loaded through two hand-operated undercut bin gates. This loading station is well ventilated by natural currents and is lighted by electricity.

The track cables in the adit are supported every 30 m. on rocking saddles which rest on built-up steel hangers suspended from 8-in. channels held in hitches and concrete in the walls. Cables are 1½-in. lock coil on loaded side and ⅞-in. on the empty. The tension on these cables is 30 tons; and with a loaded bucket of a gross weight of 1,200 kg., the sag is only about 0.25 m. The traction rope, of ⅝-in. Lang-lay plow-steel cable, is free the whole length of the adit, and the bucket interval keeps it off of the floor.

From the mouth of the La Tinta adit to the hacienda terminal the distance is 1,460 m. over fairly regular terrain. The structures between the angle station and mill are of steel and consist of three curved-rail sections and seven single towers. The track cables are the same as in the adit; likewise the traction rope. Tension is supplied by 30-ton cement blocks on the loaded side and 12-ton blocks on the empty side.

The tramway is operated in two sections, there being a change in direction of 67 deg. at the mouth of the adit, which necessitated the erection there of an angle station. This also serves as the San Francisco terminal for the Clarines tramway. The drive is a 15-hp. geared motor at the hacienda terminal, and power is transferred to the traction rope through a grip sheave. At the angle station, it runs through another grip sheave, which in turn is clutched to the same type of sheave on the adit section. By this arrangement the adit-hacienda section serves the San Francisco mine and the Clarines.

The operation is partly automatic. Buckets at the loading terminal are free from the traction rope and run by gravity on a track to the loading chutes. These are operated by hand. When the bucket is loaded, it runs down to the approach of the attacher, which locks the grip of the bucket to the traction rope. Just back of this attacher it is held by an operator, who, when the proper interval between buckets is reached, releases the bucket with a little shove, and it rides down into the attacher at the speed of the traction rope. At the angle station, the bucket is detached from the rope, runs through the structure on grade and re-attaches to the adit-hacienda section, going into the hacienda terminal, where it detaches from the rope and runs along a track over the bins. At intervals along the track are trippers which unlock the bucket and allow it to over-



OLD MINE STOPES serve as underground ore bins. Concrete reinforcement is shown, together with a section showing how sulphide and carbonate ore is dumped from the No. 1 haulage level into the sulphide ore bins and the carbonate ore bins which connect with La Tinta tramway adit. The plan of the Angle Station shows the directions of the three branches of the tramway system

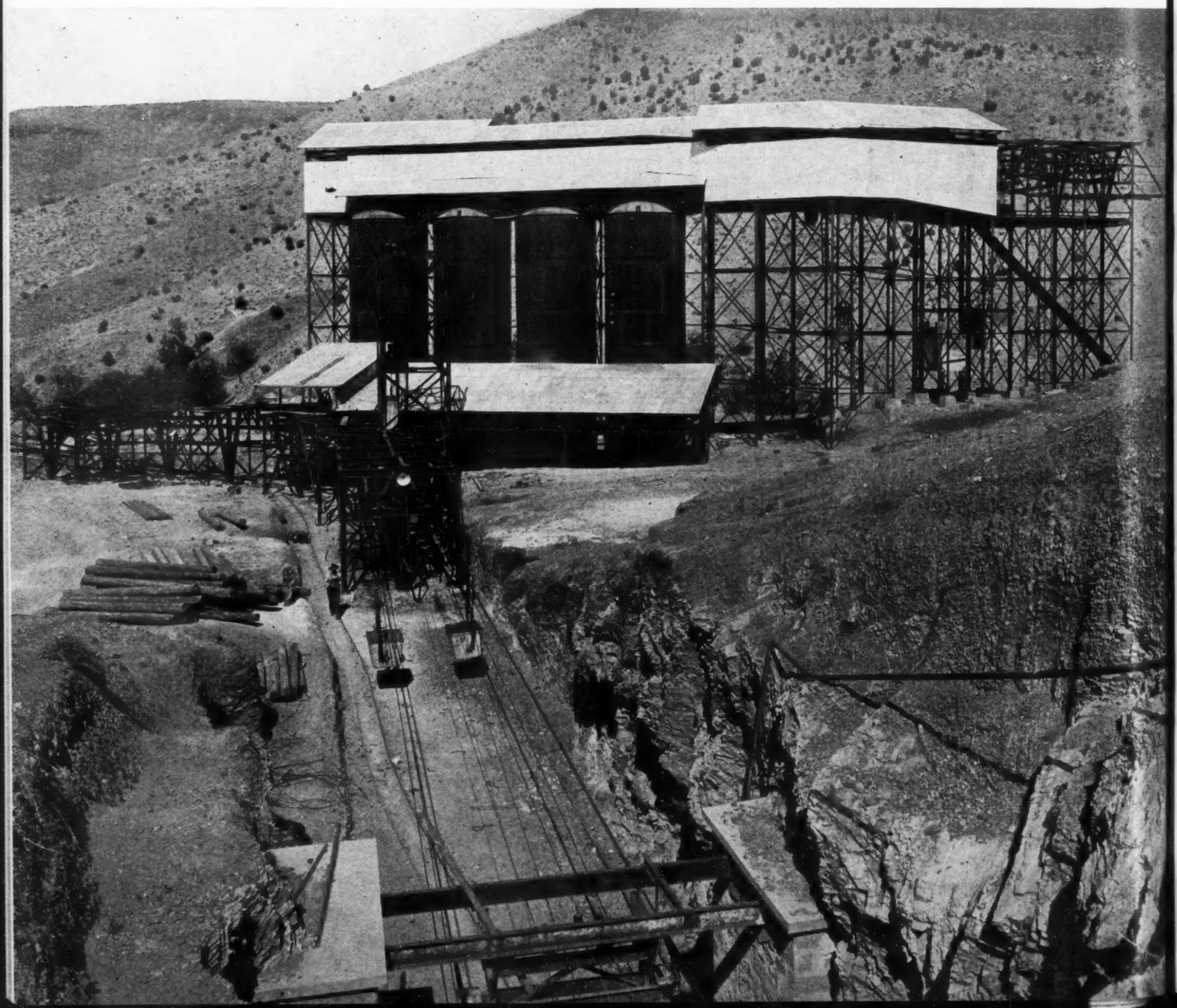
turn, dumping its load at any selected bin. It continues on around, when a workman swings the bucket back to an upright position, locking it to the hangers. Then, as at the loading station, when the proper interval is reached, the empty bucket is given a start, runs into the attacher, and is on its way for another load. Thus, a bucket in a round trip is handled by only three different workmen: the loader at the loading bins, the attacher at the loading end, and the attacher at the unloading end.

Tram capacity is 125 metric tons per hour of sulphide ore, which averages one metric ton to the bucket; and 100 metric tons per hour of oxidized ore, which weighs 800 kg. to the bucket. On the tramway from the angle station to the hacienda the buckets used weigh 200 kg. The speed at which the tramway runs is 150 m. per minute.

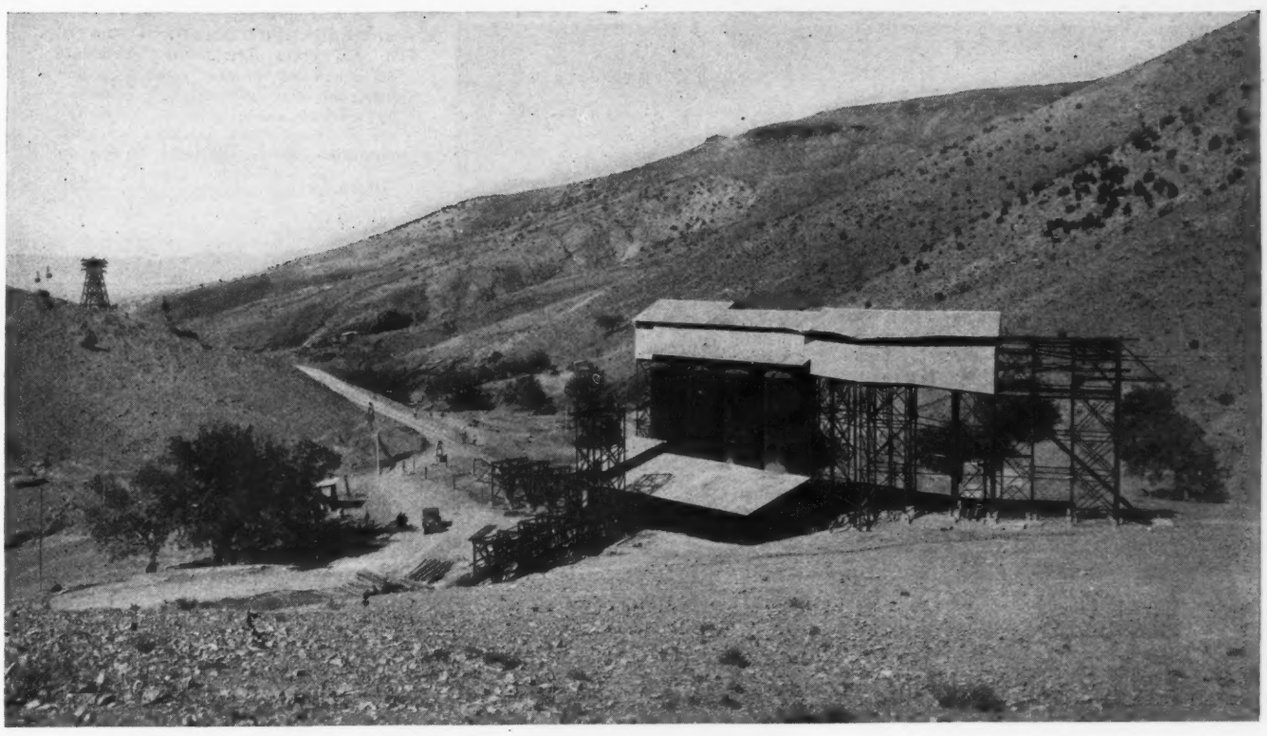
Clarines Tramway—The Clarines mine is situated 7 km. south of the hacienda, and 5 km. south of the angle station at the Tinta adit. To bring in the ores from that mine, another tramway was built, so constructed that it would also serve to transport ores from La Mesa unit. This tram crosses more difficult terrain than the Tinta-hacienda division. It starts at an elevation of 2,042 m. at the angle station and rises to elevation 2,341 m. in 3,417 m. distance, and then drops to 2,042 m. elevation in 1,612 m. distance. Although there are no record spans between towers, some of these cross rather deep arroyos and difficult terrain for repair jobs.

Although the tramway is built in two sections, these are on a straight line. The break is at the La Mesa mine unit, which will be the loading terminal for El Toro ores. There the ore will be carried on belt conveyors from the La Mesa shaft to the tramway loading bin. The entire structure, terminals and towers, is of steel. On the loaded side the track cable is $1\frac{1}{4}$-in. lock-coil cable and on the empty side is $\frac{7}{8}$-in. rope of the same type. The traction rope is $\frac{3}{4}$-in. Lang-lay plow-steel cable.

The tram is operated in two sections, with the drive at the Mesa terminal. This drive is a 40-hp. geared motor which drives the traction rope through a grip-sheave, as at the hacienda terminal. This drive is for the Mesa-angle station side of the tram, and is clutched through to another sheave which drives the Clarines-Mesa section. This is a duplicate of the drive at the angle station at the La Tinta adit. By this arrangement the Clarines ores go direct through the system to the unloading terminal at the angle station. And by unclutching the Clarines end, the El Toro ores will go to the same



THE JUNCTION of three branches of the aërial tramway. Buckets in the foreground convey ore 3,000 ft. underground on a suspended wire rope tramway. The loaded bucket is detached from its traction cable as it nears the angle, and its momentum carries it to the other traction cable, where it is automatically attached and carried to the terminal near the mill. This is the so-called Angle Station



THE ANGLE STATION, the locus of three branches of the aërial tramway. The high part of the structure and the four bins are for ore from the Clarines and El Toro units. The steel section that appears to extend into the hillside conveys ore buckets through La Tinta tunnel, which is 3,000 ft. long. That steel section extending toward the tower on the left is known as the "Frisco" ore tramway section, over which all ore passes to the mill bins in the hacienda

unloading bins. Thus flexibility is obtained in the system. Power is required when ore from Clarines is transported and is developed when transporting ore from La Mesa.

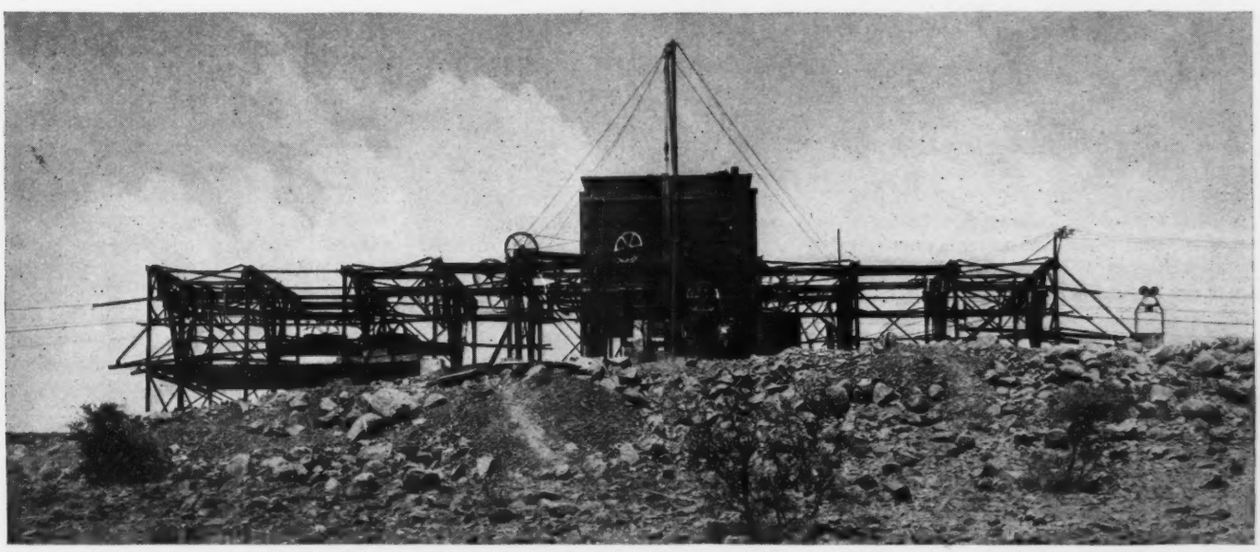
Operation of this tramway is similar to that of the San Francisco tram, being partly automatic. The only workmen who handle the machinery are the loader at the loading terminal, an operator at the motor, and an attacher at the unloading bins at the angle station. From the bins at the angle station, the ore is loaded into buckets on the angle station-hacienda section of the San Francisco tram and carried to the hacienda terminal bins.

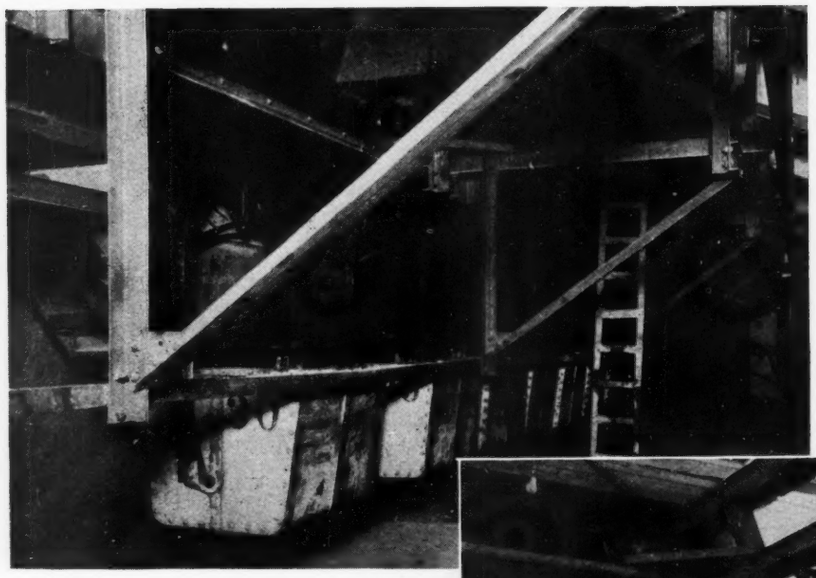
The capacity of this Clarines tramway is 50 metric tons of sulphide ores and 40 metric tons of oxide ores per hour. Its speed is 150 m. per minute.

Bin Capacities—As a possible point of interest, mention is made of the fact that the capacity of the old stopes used for bins at the San Francisco mine is 10,000 tons.

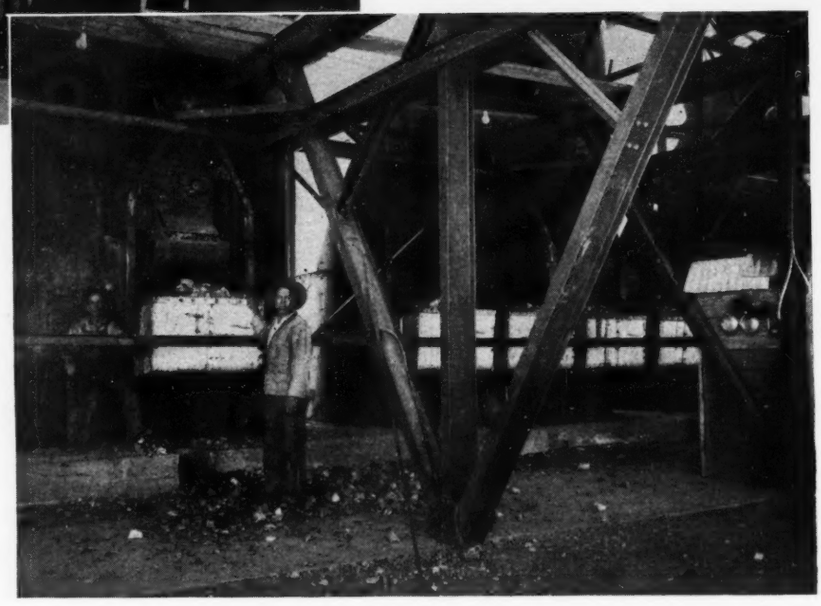
The Clarines terminal has 1,200 tons' capacity. La Mesa terminal has a small bin, which will hold 300 tons. The Clarines-La Mesa terminal at the angle station holds 1,200 tons, and the hacienda terminal furnishes another 3,200 tons of storage. These capacities give ample room for storage to continue mill operations over Sundays, as the mines work only six days a week; also to permit mine machinery, shaft, and haulage repairs, and for holidays such

LA MESA BINS, where ore is loaded and transported to the angle station 2 km. away. Ore buckets from Clarines pass in on the left through this structure on their way to the mill, but this is done only when the La Mesa bins are being filled





UNDERGROUND LOADING STATION in La Tinta adit where carbonate ore from the "Frisco" mine is loaded into one ton buckets and conveyed by traction cable 8,000 ft. where the ore is dumped into the mill ore bins. Sulphide ore is similarly loaded in another station near by



LOADING ORE AT CLARINES. Empty buckets are rolled up to the loading chute where the operator fills each bucket, capacity one-half metric ton. Loaded buckets to the right await dispatching on the traction cable which conveys them to the Angle Station at La Tinta portal

as Holy Week, when for three days whole crews are not on the job.

Service—The San Francisco tramway has been in operation since December, 1934, and handled 750,000 tons to the end of May, 1936. The Clarines tramway began operating in July, 1935, and had handled 55,000 tons to the end of May.

The operating crew of each tramway consists of nine men per shift, of which five are directly handling the tramway and four cleaning up and assisting where needed. At present Clarines is operated only on day shift. Other labor consists of repairmen, oilers and similar workmen, totaling seven men. In the event of changing cables in a breakdown, a winding gear with reduction of 120 to 1, driven by a 10-hp. motor, is used. About four hours' time is required to wind old cable out and new in on the San Francisco end. Another four hours is consumed in splicing the old cable onto the new one and resplicing the new cable and placing all buckets on the line ready for operation. To date the operating cost, including labor, power, and supplies (this item includes replacements), has been $0.023 U. S. currency per metric ton-kilometer.

Mining and Geology

(*Continued from page 390*)

Diamond drilling is done on company time, using a drill runner and helper to each shift. Carbon costs, using ⅛- to ¼-carat carbon, average $0.70 per foot drilled, *bort* costs averaging $1.44 per foot. Total costs, including equipment, preparation of drill bases, and overhead, average about $3.50 per foot.

Organization—The San Francisco Unit is in charge of H. M. Craigie, superintendent, and S. A. Mayer, assistant. Responsible to the assistant superintendent are five division foremen and one swing foreman. Each division foreman has under him three shift bosses. Shift bosses are Mexicans, as are three of the foremen. The number of men under a shift boss averages 70. The mine averages 1,080 shifts per day, 115 of these on the surface.

Clarines Unit is in charge of G. W. Voelzel, superintendent, assisted by a general mine foreman, a swing foreman, and three shift bosses. The number of men underground averages 270 daily.

El Toro Unit is in charge of J. McCord, superintendent, assisted by a general mine foreman and three shift bosses. The number of men underground averages 120 daily.

Costs—Tables V-VIII show mining costs at the San Francisco mine, all figures being expressed in American currency. Table V gives general mine costs over a ten-year period; tables VI, VII and VIII present details covering the fiscal year 1934-35.

Shrinkage stoping includes more than a normal amount of preparation. Bench stoping includes less than a normal amount, and therefore under strictly normal conditions the two methods would more closely approximate each other in cost. Cut-and-fill stoping costs are high because the system of mining was initiated in the San Francisco mine in 1934 to handle difficult sections, and much preliminary work and instruction of workmen had to be undertaken.

In Table VIII, as in those accompanying it, "Supplies" covers all operating supplies such as rock drills, cars, hoists, and any special equipment purchased. "Labor" covers all payroll payments, salaries and indemnities being included in "Overhead and Miscellaneous."

THE GENERAL MILL OFFICE, chemical laboratory, and assay office are housed in the building at the left. In the next one beyond is the testing laboratory of the plant.

Ores Treated Are Complex

Oxidation Extends Throughout the Whole Range of Minerals

George O. Deshler

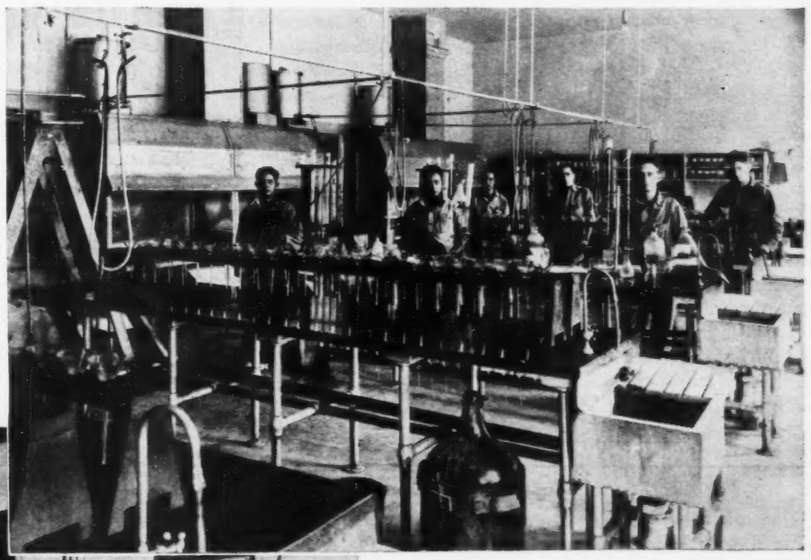
Mill Superintendent

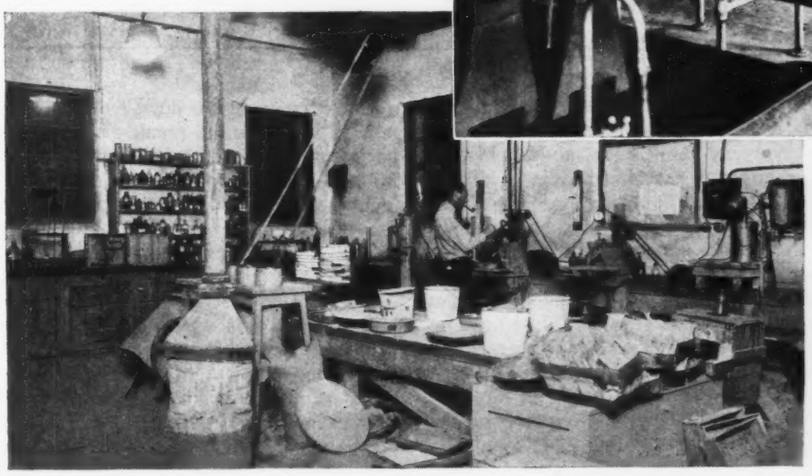
A DESCRIPTION of the efforts to treat San Francisco ore from the first attempt would really be a running account of the development of the metallurgy of complex base-metal ores. Four mills have preceded the present one; and in 1935 the latter was remodeled for the seventh time. Beginning many years ago with stamp milling, there followed hyposulphite lixiviation, jigging, dry grinding, with Wood's skin flotation and tabling, and Callow flotation.

In 1925, reagents for preferential flotation were introduced, and then followed several years of experimental work with numerous types of flotation machines. As developed and operated, the treatment is essentially as follows: Primary grinding to 20 mesh, tabling for a rougher-table lead concentrate, and secondary grinding of table tailings for flotation. All rougher flotation is done in Minerals Separation Sub-A machines, followed by cleaning in Callow standard four-mat machines, in both the lead and zinc sections. Concentrates are filtered on American filters.

The ores from the different mines of the company fall roughly into two general classes: (a) those which, using the lead as a basis, consist of approximately 90 per cent of sulphide and 10 per cent oxidized minerals, with comparatively high lead and zinc; and (b) so-called mixed ores, those which consist of approximately 60 per cent sulphide and 40 per cent oxidized minerals, with comparatively low lead and zinc. Oxidation, of course, is not confined to the lead, but extends throughout the whole range of minerals, and presents one of the major problems in milling.

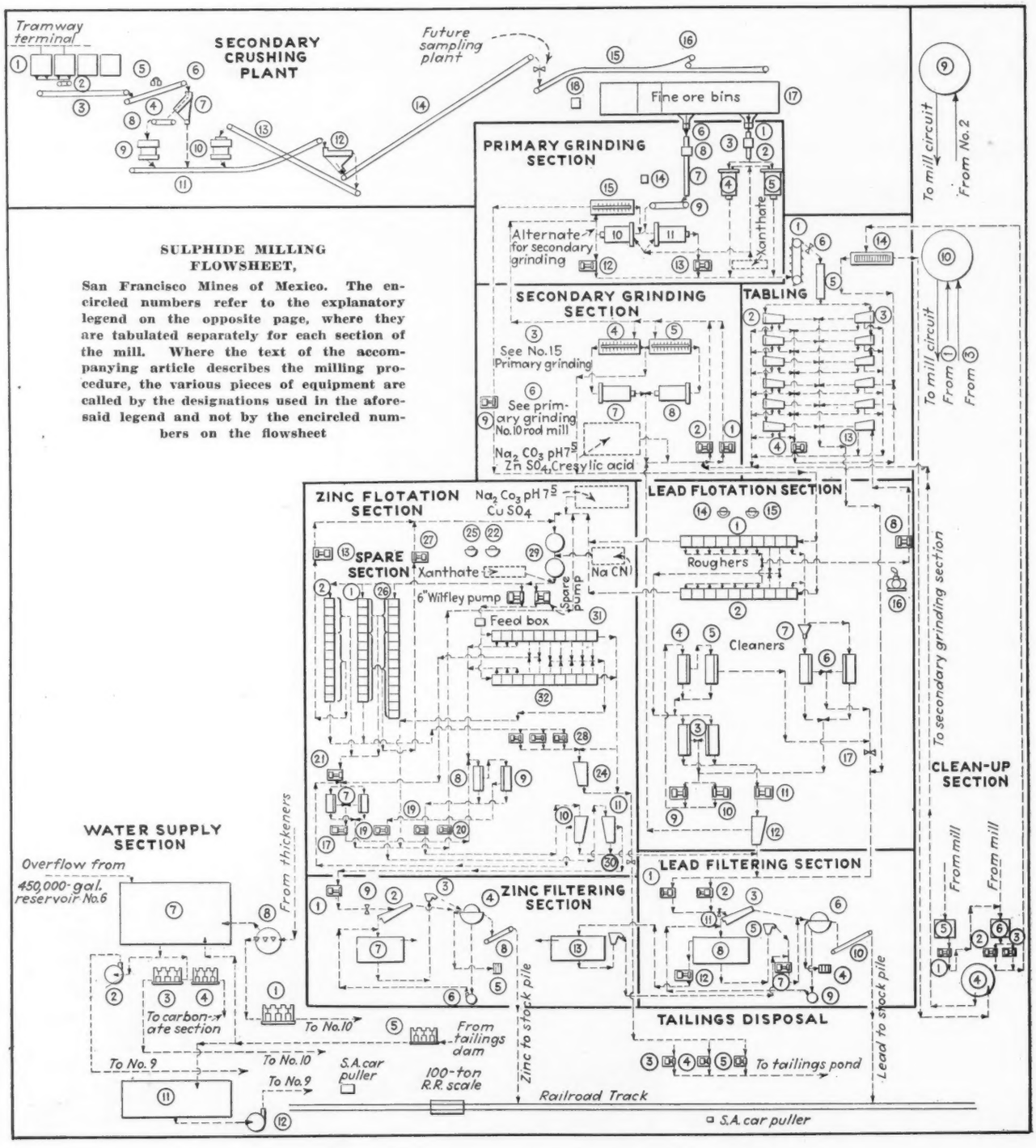
Previous to 1934, most of the sulphide ore treated came from the San Francisco vein, was relatively free from oxidation, rather high in grade as respects silver, lead, and zinc, and presented no greater problems in treatment than those usually encountered in collecting the economic minerals into their respective concentrates—with one exception, the zinc sulphide, sphalerite.





Above . . . TWENTY THOUSAND determinations per month, or about 650 per day, are made in the analytical laboratory at the mill at a cost of 10c (U. S. Currency) each. The staff includes twelve men besides the chief chemist

Left . . . IN THE TESTING LABORATORY at San Francisco del Oro. Equipment includes experimental flotation machines, a table, and such other small-scale apparatus as is necessary for studying gravity flotation and cyanidation problems



SULPHIDE MILLING FLOWSHEET,

San Francisco Mines of Mexico. The encircled numbers refer to the explanatory legend on the opposite page, where they are tabulated separately for each section of the mill. Where the text of the accompanying article describes the milling procedure, the various pieces of equipment are called by the designations used in the aforesaid legend and not by the encircled numbers on the flowsheet

Some of this mineral has always appeared with a coating of a copper mineral, probably chalcocite. With this condition, it has not been possible to inhibit the mineral as completely as could be desired, and, therefore, the lead concentrate has always carried an appreciable quantity of zinc.

After 1934, conditions were different. The supply of ore from the San Francisco vein fell off, and the deficiency was made up by ores from other veins which had been opened. Ores from these new sources varied greatly from those formerly treated. The mineralogical characteristics were different, the relative mineral ratios had changed, arsenopyrite appeared, and oxidation was quite pronounced. These differences without doubt are the result of different periods of mineralization.

Laboratory work on the newer ores indicated that to obtain the maximum economic results each would require an individual treatment. As this would be impossible, it was necessary to develop a method of treatment which, although not giving the best results on any one ore, would give acceptable results on the mixed ores.

The accompanying flowsheet, which is now in use, was the result of much experimental work, both in laboratory and mill. It is still incomplete, and experimental work is currently being done on the mill tailings, which contain more metals than is desirable, carried there by the oxide minerals.

During the last ten-year period, the mill capacity on these ores has been increased from 400 metric tons to 1,100 metric tons a day. During 1935, two separate units were added—one of 250 tons' capacity for treating the mixed ores from the San Francisco mine

FLOWSHEET LEGEND

SECONDARY CRUSHING PLANT

1. Tramway bins, 30x20 ft., capacity 3,000 metric tons
2. No. 1 apron feeder, traveling, 48x26 in.
3. No. 10 conveyor, 22 in., 116 ft. 7 in. c. to c.
4. No. 11 conveyor, 22 in., 47 ft. 10 in. c. to c.
5. Suspended magnet
6. Magnetic head pulley
7. Bar grizzly, spacing ¾ in.
8. No. 21 conveyor, movable, 20 in. c. to c.
9. No. 2 Symons cone crusher, 4 ft. standard
10. No. 3 Symons cone crusher, 4 ft. Shorthea l
11. No. 12 conveyor, 22 in., 78 ft. 6 in. c. to c.
12. No 1 Symons screen, 10 ft. x 42 in., openings ⅝x3 in.
13. No. 13 conveyor, 22 in., 76 ft. 1 in. c. to c.
14. No. 14 conveyor, 22 in., 170 ft. 3 in. c. to c.
15. No. 15 conveyor. 20 in., 105 ft. 6 in. c. to c.
16. Tripper
17. Fine ore bins, capacity 3,000 metric tons
18. No. 1 exciter set

PRIMARY GRINDING SECTION

1. No. 1 apron feeder, 38x20 in.
2. No. 16 conveyor, 16 in., 39 ft. c. to c.
3. No. 2 Weightometer
4. No. 1 rod mill, 6x10 ft.
5. No. 3 rod mill, 5x10 ft.
6. No. 2 apron feeder
7. No. 17 conveyor, 16 in., 72 ft. 1 in. c. to c.
8. No. 1 Weightometer
9. No. 18 conveyor, 16 in., 27 ft. 8 in., c. to c.
10. No. 6 rod mill, 6x10 ft.
11. No. 5 rod mill, 5x10 ft.
12. No. 11 Wilfley pump, 4 in.
13. No. 31 Wilfley pump, 4 in.
14. No. 2 exciter set
15. No. 6 Dorr classifier, 8x24 ft.

SECONDARY GRINDING SECTION

1. No. 2 Wilfley pump, 6 in.
2. No. 4 Wilfley pump, 6 in.
3. No. 6 Dorr classifier, 8x24 ft.
4. No. 4 Dorr classifier, 6x18 ft. 4 in.
5. No. 2 Dorr classifier, 6x18 ft. 4 in.
6. No. 6 rod mill, 6x10 ft.
7. No. 4 rod mill, 6x10 ft.
8. No. 2 rod mill, 6x10 ft.
9. No. 33 Wilfley pump, 4 in.

TABLING SECTION

1. No. 1 elevator, 8x16 in., 75 ft.
2. No. 1, 6 Deister tables
3. No. 7, 6 Deister tables
4. No. 62 Wilfley pump, 3 in. middling
5. Distributor-classifier
6. Sampler
13. No. 11 Deister table
14. No. 15 classifier drag

LEAD FLOTATION SECTION

1. No. 6 M-S flotation machine, 24 in., 10 cell
2. No. 7 M-S flotation machine, 24 in., 10 cell
3. No. 2 Callow cleaner, 2 cells
4. No. 3 Callow cleaner, 1 cell
5. No. 13 Callow cleaner, 1 cell
6. No. 6 Callow cleaner, 2 small cells
7. No. 2 hydraulic classifier
8. No. 1-No. 3 Wilfley pump, 4 in.
9. No. 23 Wilfley pump, 6 in.
10. No. 24 Wilfley pump, 6 in.
11. No. 56 Wilfley pump, 3 in.
12. No. 15 Deister table
14. Reagent mixing
15. Reagent feeders
16. Blowers
17. Sampler

ZINC FLOTATION SECTION

1. No. 2 M-S flotation machine, 18 in., 12 cells
2. No. 3 M-S flotation machine, 18 in., 12 cells
7. No. 4 Callow cleaner
8. No. 5 Callow cleaner
9. No. 14 Callow cleaner
10. No. 14 Deister table
11. No. 13 Deister table
13. No. 61 Wilfley pump, 4 in.
17. No. 5 Wilfley pump, 4 in.
18. No. 6 Wilfley pump, 4 in
19. No. 9 Wilfley pump, 4 in.
20. No. 10 Wilfley pump, 4 in.
21. No 26 Wilfley pump, 4 in.
22. Reagent mixing
24. No. 2 pilot table
25. Reagent feeders
26. No. 1 M-S flotation machine, 18 in., 16 cells
27. No. 20 Wilfley pump, 2 in.
28. No. 5 38-63-64 Wilfley pumps, 4 in.
29. Agitating tanks
30. Sampler
31. No. 8 M-S flotation machine, 24 in., 10 cell
32. No. 9 M-S flotation machine, 24 in., 10 cell

LEAD FILTERING SECTION

1. No. 16 Wilfley pump, 2 in.
2. No. 17 Wilfley pump, 2 in.
3. No. 12 Dorr classifier, 2 ft. 6 in. x 15 ft.
4. No. 1-2-3 vacuum pumps, one 12x6 in., two 18x6 in.
5. Diaphragm pump
6. No. 1 American filter, 6 ft., 4 disk
7. No. 58 Wilfley pump, 2 in.
8. No 1 Dorr thickener, 30x10 ft.
9. No. 27 Krogh pump, 2 in.
10. No. 3 conveyor, 16 in., 120 c. to c.
11. Sampler
12. No. 64 Wilfley pump, 4 in.
13. No. 4 Dorr thickener, 30x10 ft.

ZINC FILTERING SECTION

1. No. 19 Wilfley pump, 4 in.
2. No. 5 Dorr classifier, 3 ft. 6 in. x 18 ft.
3. Diaphragm pump.
4. No. 2 American filter 8 ft. 6 in., 4 disk.
5. See lead filter section No. 4
6. No. 28 Krogh pump, 2 in.
7. No. 2 Dorr thickener, 30x10 ft.
8. No. 4 conveyor, 16 in., 190 ft. c. to c.
9. Sampler

WATER-SUPPLY SYSTEM

1. No. 4 triplex pump, 8x10 in.
2. 6 stage centrifugal pump, 4 in.
3. No. 6 triplex pump, 7x10 in
4. No. 1 triplex pump, 6x8 in. to carbonate section
5. No. 5 triplex pump, 9x12 in.
6. Fresh water, 450,000 gal. reservoir
7. Return water, 450,000 gal. pila
8. No. 4 triplex suction tank
9. No. 2 return water tank, 50,000 gal.
10. No. 3 return water tank, 50,000 gal.
11. No. 5 return water tank, 900,000 gal.
12. No. 7-8 Cameron centrifugal pumps, 3 in.

TAILINGS DISPOSAL

3. No. 59 Wilfley pump, 6 in.
4. No. 65 Wilfley pump, 6 in.
5. No. 29 Wilfley pump, 6 in.

CLEAN UP SECTION

1. No. 18 Wilfley pump, 2 in.
2. No. 30 Wilfley pump, 4 in.
3. No. 32 Wilfley pump, 4 in.
4. No. 3 Dorr thickener, 48x10 ft.
5. No. 1 clean up pila
6. No. 2 clean-up pila

previously mentioned, and one of like capacity for treating a somewhat similar mixed ore from the company's Clarines mine.

Plans are under way for a 250-ton unit to treat sulphide ores having a relative high lead-zinc ratio. The zinc concentrate will carry the precious metals in appreciable amounts and will be marketed separately.

Crushing Plant—From the tramway terminal bins, two in service on San Francisco sulphide, and one each on San Francisco oxidized and Clarines oxidized ores, the ore is withdrawn through eight bottom chutes, two to each bin. Feed from the chutes is controlled by double-acting, hand-operated arc gates. The ore is fed from the bins through these chutes by means of a pan conveyor feeder, mounted on a truck which runs on rails directly above No. 10 conveyor. The feeder measures 48x16-in. It discharges directly upon No. 10 conveyor, which runs lengthwise through a tunnel under the bins, and delivers to No. 11 conveyor. The latter travels at right angles to No. 10, and is inclined at 15 deg. A magnet of Magnetic Manufacturing Company design is suspended over this belt; also, the conveyor is equipped with a Dings magnetic head-pulley, 30x24-in. Practically all tramp iron is eliminated from the feed at these points.

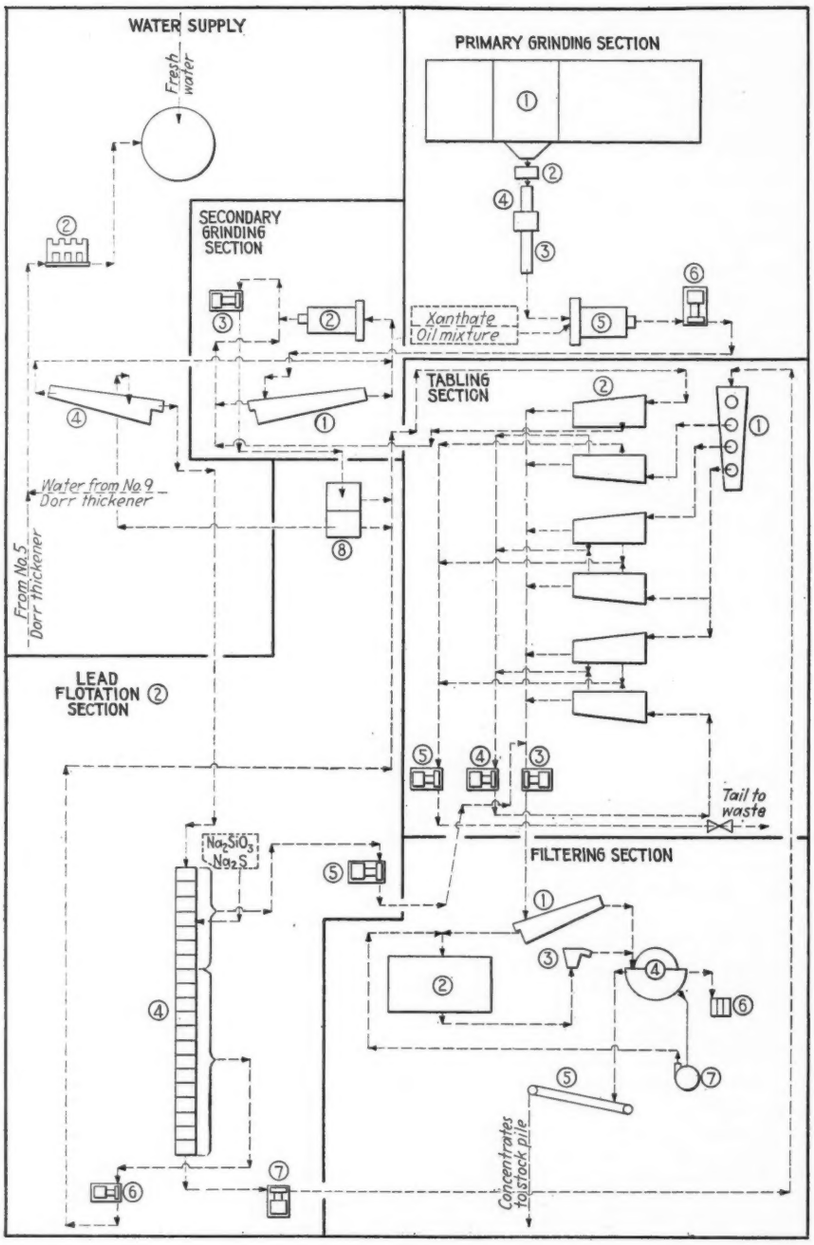
No. 11 conveyor discharges upon a grizzly with bars spaced at 1 in., oversize dropping upon No. 21 conveyor, which feeds the primary crusher, and undersize going to No. 12 conveyor, which takes the discharge of both primary and secondary crusher. No. 21 conveyor is a 22-in., five-ply belt, 14 ft. center to center, and is mounted in a frame of wheels, so as to be drawn out of the way when repairing the crusher. The ore is discharged from No. 21 conveyor to No. 2 Symons standard 4-ft. cone crusher. This crusher is set at ¾-in. and discharges upon No. 12 conveyor, which moves at 300 ft. per minute and discharges to No. 1 Symons screens. The area of the screen is 10 ft. by 42 in. and the screen cloth is Tyler Ty-rod, with ⅝x3-in. openings. Oversize from the screen drops to No. 13 conveyor, which discharges to No. 3 Symons 4-ft. Shorthead cone crusher. This crusher discharges to No. 12 conveyor, feeding the Symons screen, forming a closed circuit.

The Symons screen undersize passes to No. 14 conveyor, which is inclined at 21 deg., and elevates the ore to the top of the fine-ore bins, where it discharges to No. 15 conveyor, running lengthwise over the top of the bins. This conveyor is equipped with a hand-propelled tripper, by means of which the crushed ore is dropped into the fine-ore bins. The fine bins have an approximate capacity of 2,000 tons of sulphide ore and 500 tons each of the two oxidized ores.

Motors throughout the crushing plant are of necessity distributed over a wide area. Control, however, is centered in a room near the crushers. All feeding and conveying equipment is so hooked up that a kick-out or motor trouble on any driving unit will automatically throw out all motors ahead of it, allowing those to the rear to run. This eliminates spills or the piling up of material, should trouble occur on any one unit.

The crushing plant, as described, has a normal capacity on dry ore of approximately 100 tons an hour, crushing to all minus ½ in. On wet ore, this falls off considerably, as the grizzly is not efficient in screening out all the fine wet material. It is planned to replace the grizzly with a 10 ft. by 42-in. Symons double-deck screen, using on the top deck a screen cloth with a 3x1-in. opening, oversize dropping to the primary Symons crusher, and on the bottom deck a cloth having ⅝x3-in. openings, discharging its oversize to the secondary Symons crusher. The minus-⅝-in. material would be conveyed direct to the fine bins. This will eliminate any trouble caused by fines getting into the primary crusher.

The Sulphide Unit. Primary Grinding—Feed for this section is drawn from the mill storage bin by two Stephens-Adamson pan conveyor feeders operating at constant speed. The feeders are driven by belt from the subsequent conveyors, and no trouble is experienced in maintaining a constant feed. Regulation is by a swing gate operated by a hand wheel. Each feeder discharges to a conveyor, the load being split between two mills. No. 16 conveyor, feeding Nos. 1 and 3 mills, is



SAN FRANCISCO CARBONATE SECTION FLOWSHEET

The encircled numbers refer to the accompanying legend. Although the flowsheets of this and the Clarines section, as well as of the sulphide milling, are presented separately, the three circuits are all under one roof in the concentrator

PRIMARY GRINDING SECTION

1. Fine-ore bins
2. No. 4 pan conveyor, 38x20 in.
3. No. 20 conveyor 16 in., 38 ft. 9½ in. c. to c.
4. No. 2 Weightometer
5. No. 7 Marcy rod mill, 5x8 ft.
6. No. 35 Wilfley pump, 3 in.

TABLING SECTION

1. No. 1 Deister hydraulic classifier
2. No. 16 No. 21 Deister sand tables
3. No. 37 Wilfley pump, 2 in.
4. No. 39 Wilfley pump, 2 in.
5. No. 40 Wilfley pump, 4 in.

SECONDARY GRINDING SECTION

1. No. 9 Dorr classifier, 4 ft. 6 in. x 18 ft.
2. No. 9 Marcy rod mill, 5x8 ft.
3. No. 34 Wilfley pump, 4 in.
4. No. 13 Dorr classifier, 4 ft. 6 in. x 18 in.

LEAD FLOTATION SECTION

4. No. 4 M-S flotation machine, 18 in., 20 cells
5. No. 60 Wilfley pump, 2 in.
6. No. 53 Wilfley pump, 2 in.
7. No. 12 Wilfley pump, 4 in.
8. No. 11 M-S flotation machine, 24 in., 2 cell

LEAD FILTERING SECTION

1. No. 12 Dorr classifier, 2 ft. 10 in. x 18 ft.
2. No. 1 Dorr thickener, 30x10 ft.
3. No. 1 Dorrco diaphragm pump
4. No. 1 filter, American, 6 ft., 4 disk
5. No. 3 conveyor, 16 in.
6. No. 1-2-3 vacuum pumps, two 12x6 in. one 18x6 in.
7. No. 42 centrifugal pump filtrate.

WATER SUPPLY

1. Steady-head tank, 9,000 gal.
2. Triplex pump, 6x8 in.

16 in. and 5 ply. Feed is delivered to Nos. 5 and 6 mills by Nos. 17 and 18 conveyors. Nos. 16 and 17 conveyors are equipped with Merrick Weightometers.

No. 1 mill is a 5½x10-ft. Cole-Bergman unit equipped with Marcy rollers, and is driven at 22 r.p.m. by a 100-hp., 570-r.p.m. slipring induction motor, through a Tex-rope drive, and spur gear and pinion, ratio 8.4 to 1.

No. 3 mill, a 5x10-ft. Allis-Chalmers, running at 20 r.p.m., is belted from a 100-hp., 580-r.p.m. slipring motor through spur gear and pinion, ratio 5.3 to 1.

No. 5 mill, an Allis-Chalmers 5x10-ft., is direct-connected to a 100-hp., 400-r.p.m. synchronous motor through a Cutler-Hammer magnetic clutch, Wuest gear pinion, and is operated at 23.5 r.p.m.

No. 6 mill, an Allis-Chalmers 6x10-ft. unit, is direct-connected to a 150-hp., Westinghouse, 360-r.p.m. super-synchronous motor, with internal automatic magnetic clutch, Wuest gear and pinion, and runs at 17.5 r.p.m.

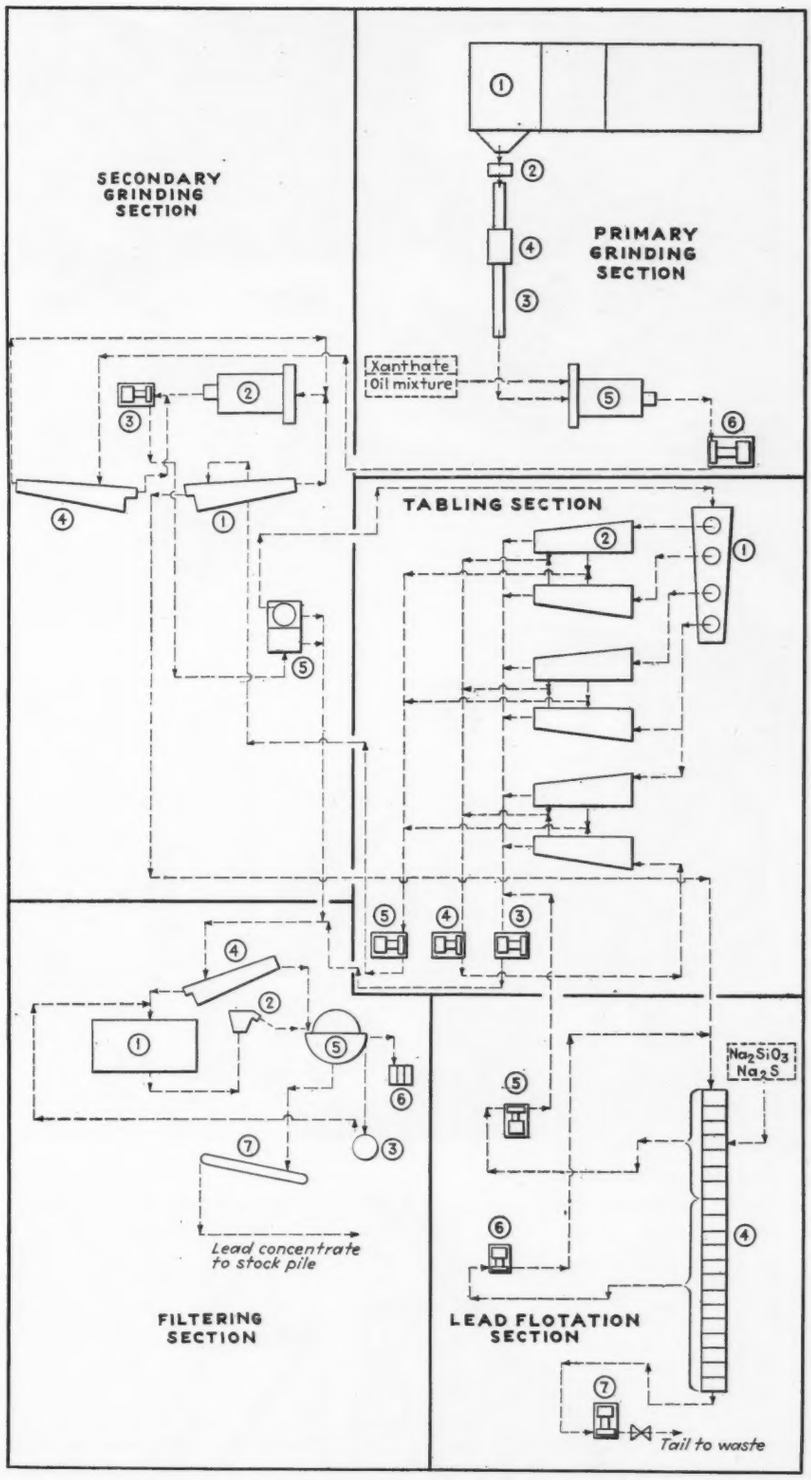
All primary mills use 3½-in. rods, having in part this approximate percentage analysis: Cr, 0.24; SiO_2 0.13; Mn, 0.65; C, 0.87; S, 0.04; P, 0.02. Rods are manufactured by Cia. Fundidora de Fierro y Acero de Monterrey, Mexico.

Table Section—The discharge of all primary mills is collected at the boot of No. 1 elevator, Nos. 1 and 3 direct and Nos. 5 and 6 by means of 4-in. Wilfley pumps, Nos. 31 and 11 respectively, as shown on the flowsheet. No. 1 elevator, the only one in the mill, 30 ft. center to center, 18-in. buckets, running at 425 ft. per minute, discharges into a distributing classifier, which is simply a Deister classifier without hydraulics. The feed is sent to nine Deister Plat-O tables, from which is taken a coarse lead concentrate. Middlings are made and are sent to two tables by a 3-in. Wilfley pump, run by a 7½-hp. motor.

Concentrate from all tables, representing 40 per cent of the total lead in a 72 per cent concentrate, is sent to the filter plant by a 2-in. Wilfley pump direct-connected to a 10-hp., 1,800-r.p.m. motor. In addition to relieving the lead flotation circuit of a part of its load, and equalizing more or less the lead head to the flotation circuit, we recover here a coarse lead product which is of great benefit in producing a porous cake in filtering the combined lead concentrates. The filter cake on straight flotation concentrate averages 11 to 12 per cent moisture. When combined with the table concentrate, this is brought down to 7½ to 8 per cent.

These rougher tables are in two rows of six each, the machines in each row driven from a line shaft, each of which in turn is driven by a 10-hp., 860-r.p.m. motor. Table tailings are sent to the secondary grinding section.

Secondary Grinding—The rougher-table tailings are collected and pumped to No. 2 and No. 4 Dorr classifiers.



CLARINES CARBONATE SECTION FLOWSHEET.

The encircled numbers refer to the accompanying legend. A finished concentrate is made immediately after the secondary grinding, the tails thereof are tabled and returned to the grinding circuit, and the classifier overflow goes to final flotation

PRIMARY GRINDING SECTION

1. Fine-ore bins
2. No. 5 pan conveyor, 38x24 in.
3. No. 19 conveyor, 16 in., 38 ft. 9½ in. c. to c.
4. No. 3 Weightometer
5. No. 8 Marcy rod mill, 4x8 ft.
6. No. 36 Wilfley pump, 2 in.

TABLING SECTION

1. No. 2 Deister hydraulic classifier
2. No. 22-27 Deister sand tables
3. No. 43 Wilfley pump, 2 in.
4. No. 44 Wilfley pump, 2 in.
5. No. 45 Wilfley pump, 4 in.

SECONDARY GRINDING SECTION

1. No. 10 Dorr classifier, 4 ft. 6 in. x 18 ft.
2. No. 10 Marcy rod mill, 4x8 ft.
3. No. 21 Wilfley pump, 4 in.
4. No. 14 Dorr classifier, 4 ft. 6 in. x 18 in.
5. No. 10 M-S flotation machine, 24 in., 2 cells

LEAD FLOTATION SECTION

4. No. 5 M-S flotation machine, 18 in., 20 cells
5. No. 35 Wilfley pump, 2 in.
6. No. 36 Wilfley pump, 2 in.
7. No. 12 Wilfley pumup, 4 in.

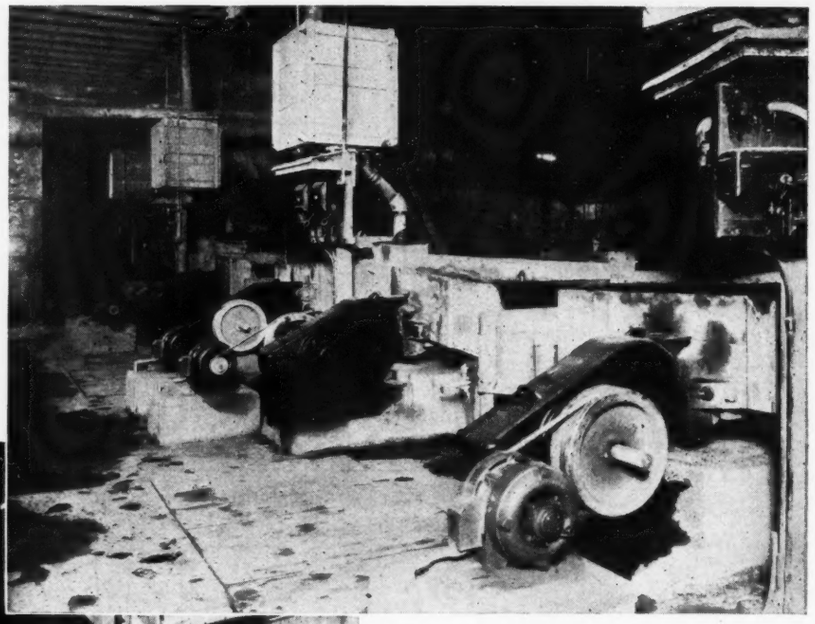
LEAD FILTER SECTION

1. No. 9 Dorr thickener, 30x10 ft.
2. No. 9 Dorrco diaphragm pump
3. No. 42 centrifugal pump, 2 in.
4. No. 11 Dorr classifier, two 10x18 in.
5. No. 3 American filter, 6 ft. 4 disk
6. No. 1, 2, 3, 4 vacuum pumps
7. No. 22 conveyor 16 in.

These are 6x18-ft. 4-in., Model D classifiers, with a 2¾-in. to 12-in. slope, and run at 30 strokes per minute. Classifier sands drop to Nos. 2 and 4 Cole-Bergman mills, using 2½-in. rods. The mills are equipped with Marcy rollers and driven by slipring motors. These secondary mills and classifiers are in closed circuit, the mill discharge joining the rougher-table tailings at No. 2 Wilfley pump, and thence going to the classifiers.

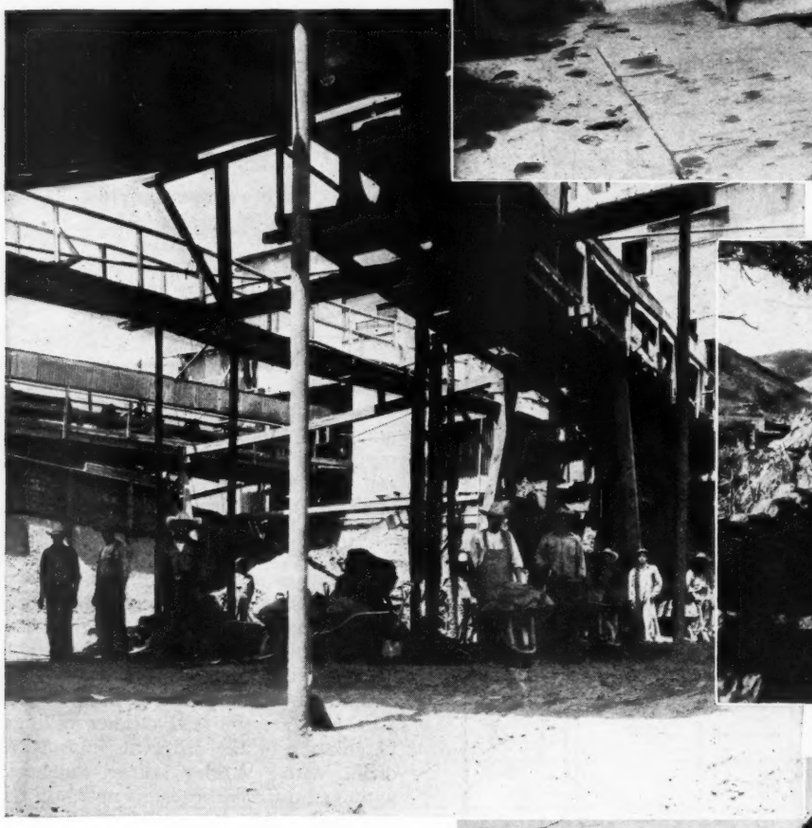
Lead Flotation—The classifier overflow constitutes the original feed to the lead flotation roughers. These are two M. S. Sub-A 24-in. machines (Nos. 6 and 7) of ten cells each, with Tex-rope drives, having one vertical motor, 10-hp., 1,160 r.p.m., to each two cells. Held in reserve for use during repairs is No. 1, a 16-cell, 18-in. gear-driven M. S. Sub-A machine. These machines all make a primary rougher concentrate, a secondary rougher concentrate, a middling, and a tailing. The primary rougher concentrate is cleaned once, and the secondary concentrate twice and sometimes three times, for a finished product. Cleaning is all done in standard Callow four-mat machines. Cleaning in mechanical machines has not proved successful. Middlings are sent to a Deister table, No. 11, used as a pilot table, and the tailing from this table flows to the secondary mill classifier circuit. A standard Plat-O table is used as a pilot on the lead cleaner tailings. Circulation of the different pulps is all done with Wilfley direct-connected pumps of different sizes, as noted on the flowsheet. Air for all M. S. flotation machines is taken from the air mains and reduced to 1½-lb. by standard pressure reducers.

Zinc Flotation — Tailings from the lead flotation section are sent to two Denver Equipment Company agitators, in series, for two separate ten-minute periods of contact. The agitators are 10x10 ft., driven by vertical motors of 7½-hp., 1,160 r.p.m. through Tex-rope drives. Overflow from the last tank is pumped by a 6-in. No. 23 Wilfley pump, direct-connected to a 30-hp., 900-r.p.m. motor, to the zinc rougher machines. These are exact duplicates of the lead roughers, and make similar products; that is, rougher concentrates, middlings, and a final tailing. The rougher concentrates are cleaned three times for a finished product, the middling returns to the agitating tanks ahead of the

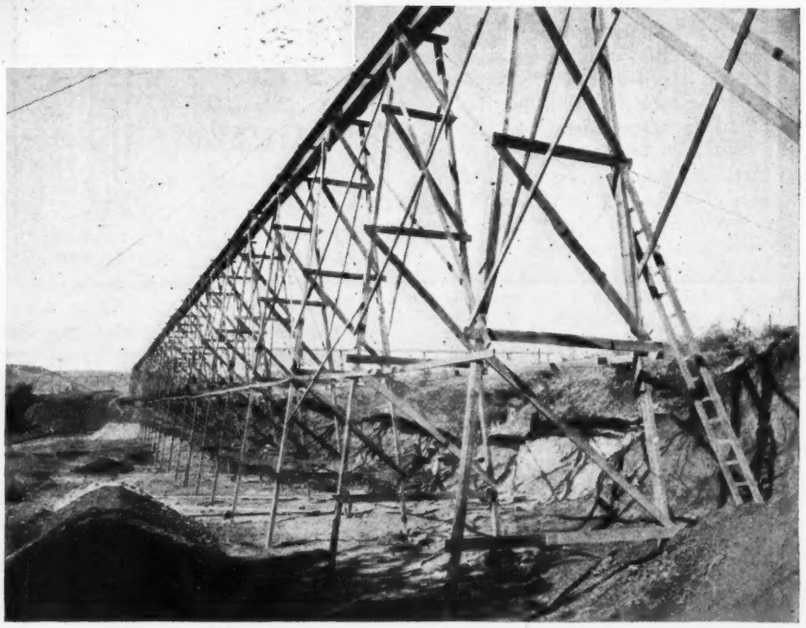


Right . . . THESE SIX TABLES treat the tailings from the two-cell M-S Sub A flotation machine (that makes a finished lead concentrate from the discharge of the secondary grinding mill) in the Clarines carbonate section

Below . . . STORAGE PATIO at the mill for sulphide lead concentrate. The latter is delivered to this point by the overhead conveyor and is then loaded into freight cars by wheelbarrows and shipped to Torreon



Right Center . . . CRUDE CHILEAN MILL where mules go round and round from sunrise to sunset pulling the two basalt boulders in the grinding circuit of this ancient metallurgical process. A Mexican constructed this plant for his own use



Right . . . TAILINGS DISPOSAL is effected through launders lined with white iron that run from the various sections to a central point, where the tails are sampled and pumped to the dam 500 m. away. This trestle skirts the edge of the new dam site, large enough for the next 20 years

rougher circuit, and the tailing constitutes the final mill tailing, which is sent to waste.

As noted under lead flotation, circulation of the different pulps is done by Wilfley pumps. Standard-size Plat-O tables are used as pilot tables on the zinc cleaner tailings and finished zinc concentrate. Part of the final tailing passes over a half-size Wilfley pilot table for observation.

Filter Plant—The combined lead concentrate from various sources is pumped by a 2-in. direct-connected Wilfley pump to a No. 12 Dorr classifier set on a slope of 1½ in. and operating at ten strokes per minute. Classifier sands drop directly to No. 1 lead filter. Classifier overflow is sent to No. 1 Dorr thickener. The thickened pulp, at 80 per cent solids, is withdrawn by a diaphragm pump and sent to join the classifier sands at the filter. Tank overflow becomes part of the returned water used in the mill. The combined feed drops into the filter, an American 6-ft. four-disk machine making one revolution in 3½ min.

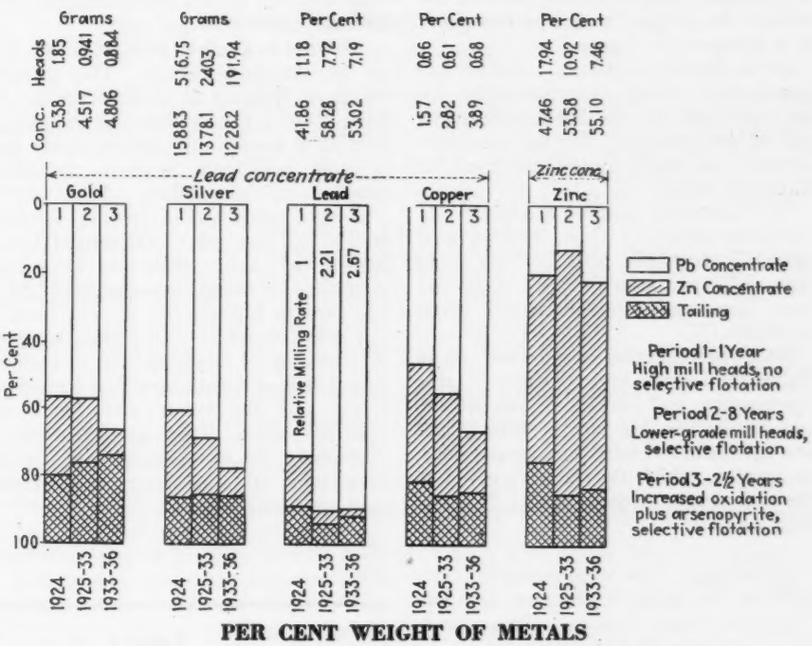
From here, the filter cake, running 7 to 8 per cent in moisture, drops to No. 3 conveyor, 16 in. 5 ply, 50 ft. center to center, running at 130 ft. per minute, and is sent to the concentrate loading patio. Lead concentrate is shipped to Torreon, Mexico, and the zinc concentrate to Belgium via Tampico.

The filtrate is withdrawn through a barometric leg into a cone, from which it is returned by a 3-in. Krogh centrifugal pump, to No. 1 Dorr thickener.

Zinc concentrate is handled in a similar manner. The filter in use here, however, is an 8-ft. four-disk American, one disk only being in use.

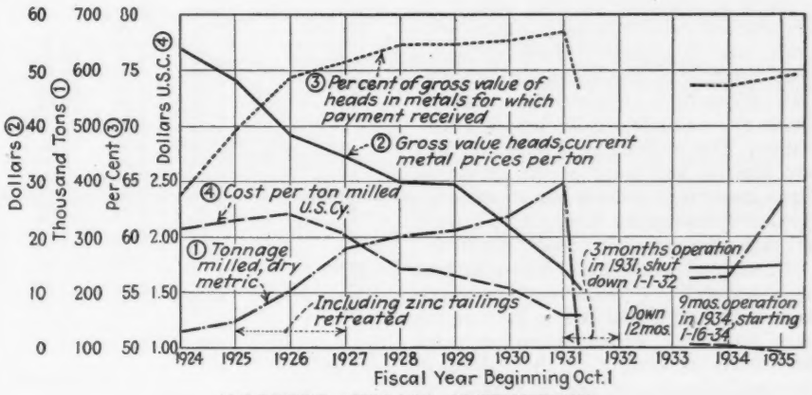
Floor wash and clean-up of all kinds is collected at the foot of the mill in sumps, from which it is pumped by direct-connected 4-in. Wilfley pumps to a drag classifier in the sulphide table section. The sands drop to a Deister Plat-O table; the lead concentrate joins the normal table lead concentrate; and the tailing drops to the secondary grinding circuit. Overflow from the drag classifier is fed to a 45x10-ft. Dorr thickener. A diaphragm pump discharges the thickened pulp to the secondary grinding unit, and the tank overflow joins the circulating mill-water supply.

Economic Considerations—In the treatment of any ore, the ultimate objective is obviously the greatest economic return. This does not necessarily mean the highest recoveries or the highest products. On a simple ore, the optimum conditions to be established and held are fairly easily determined. On a complex ore the opposite is the condition. A "happy medium" or balance must be struck in respect to recoveries on the individual minerals and grades of products.



PER CENT WEIGHT OF METALS

in products of San Francisco Mines of Mexico are shown by these graphs for the year 1924, the period 1925 to 1933 and the period 1933 to 1936


Dollars ②
Thousand Tons ①
Per Cent ③
Dollars U.S.C. ④
③ Per cent of gross value of heads in metals for which payment received
② Gross value heads, current metal prices per ton
④ Cost per ton milled U.S.Cy.
① Tonnage milled, dry metric
Including zinc tailings retreated
3 months operation in 1931, shut down 1-1-32
Down 12 mos.
9 mos. operation in 1934, starting 1-16-34
1924 1925 1926 1927 1928 1929 1930 1931 1932 1933 1934 1935
Fiscal Year Beginning Oct. 1

SULPHIDE MILLING OPERATIONS

from 1924 to 1935 inclusive. The four curves are broken by a gap of 24 months' duration, during which period operations were suspended

With a variety of minerals, all carrying precious as well as base metals in varying amounts, and all responding differently to treatment, the problem of maintaining a balanced condition for maximum economic returns requires constant attention. What may be a reasonable set-up under any one condition may be thrown out of balance not only by a change in the mineralogical characteristics of the ore being treated, but also by a change in price affecting one or more metals.

A case in point is the comparatively recent increase in the price of gold and silver, relative to the price of the base metals. A sacrifice could be made in grades of products and recoveries of the base metals to get the advantage of increased recoveries and increased returns from the precious metals.

In a complex ore, the relative economic return cannot be predicated on any one metal but must include all. To facilitate such comparison, San Francisco uses a simple plan which has been of considerable help in this respect. It is applied not only to current metallurgy, but is used to determine the relative value of work of importance in the testing laboratory.

In a problem under discussion, the analyses of the base metals which are desired in any concentrate or concentrates are recast to their respective mineral or minerals, which are then totaled for a 100 per cent mineral content. From this, then, is determined the theoretical perfect ratio of concentration, and the assays of the different metals are readily calculated. In other words, we would have a 100 per cent recovery of the metals, in their respective concentrates, in a perfect concentrate. These concentrates are then liquidated under the same conditions as

the products under discussion, and the ratio of the original to the perfect gives us a comparative figure.

At the San Francisco mill, the perfect concentrates carry approximately 72 per cent lead for the lead concentrate, and 62 per cent zinc for the zinc concentrate, and these figures are used for all comparisons.

To illustrate, assume heads of the following analysis: Gold, 1.532 gram; silver, 175.6 grams; lead, 7.72 per cent; zinc, 5.59 per cent; copper, 0.54 per cent. The metallurgical balance is given in Table III.

Such percentages, as arrived at in Table III for the lead concentrate, zinc concentrate, and combined concentrate, can be derived for any condition, and are particularly useful for comparisons, in cases in which the value is given to the concentrate or concentrates, by more than one metal.

Metallurgy—The most important minerals in the sulphide ore from the San Francisco mine, from a milling standpoint, are indicated in Table IV.

A perfect separation and grouping of the minerals would be as given in Table V.

Such a grouping as this might be approached with perfectly clean minerals. It is hardly possible, however, under conditions such as obtain at San Francisco, where the minerals show approximately a 10 per cent oxidation. The carbonates of lead and zinc are present, and much of the sphalerite has a coating of a black copper mineral, probably chalcocite. A slight acid wash gives a characteristic copper reaction.

In normal unoxidized lead-zinc ore, it is not difficult to depress the sphalerite. At San Francisco, a part of the zinc has been activated underground and floats as readily as the galena in the lead circuit, making it almost impossible to produce a lead concentrate much under 15 per cent zinc, without a disproportionate loss of lead and silver.

In times past, it had been the practice to add both the zinc sulphate and sodium cyanide to the lead circuit. After arsenopyrite made its appearance in quantity, the depressing effect of the combination was too great. Arsenopyrite was forced into the lead tailing and found its way into the zinc concentrate, so that at times this concentrate carried 1 per cent more of arsenic. As the penalty on arsenic begins at 0.4, this had to be corrected.

The cyanide, which seems to be the more positive depressant on the arsenopyrite, was taken out of the lead circuit. This allowed a considerable part of the arsenopyrite to float with the lead concentrate. The lead flotation tailing is then agitated for 10 min. with copper sulphate to reactivate the sphalerite, and the remainder of the arsenic inhibited by a 10-min. agitation with sodium cyanide.

The arsenic content of the zinc concentrate, due to this pre-treatment, will average under 0.20 per cent.

Fluorite is another mineral which has to be watched closely. The penalty starts on fluorine at 0.26 per cent. As each 0.01 per cent fluorine in excess carries a penalty of approximately 6c., a high additional smelter deduction could easily be reached.

Power consumption in the sulphide mill in the fiscal year 1935 totaled 25.638 kw.-hr. per ton. Iron and steel consumption for the same period was 1.8121 kg. per ton milled.

Carbonate Units—Two units, each of 250 tons' daily capacity, are in service. One treats ore from the San Francisco mine and the other ore from the Clarines mine. They are identical in character, the differences being in the treatment only. A description of one will serve for both.

Ore from the fine-ore bin is fed to Nos. 19 and 20 conveyors by Stephens-Adamson pan conveyor feeders, Nos. 4 and 5, and driven at a constant speed from the tail pulleys of the conveyors. The conveyors, which are equipped with Merrick Weightometers, travel at 90 ft. per minute and deliver to 5x8-ft. Marcy primary mills using 3½-in. rods. The mill discharge is pumped to Nos. 9 and 10 Model C Dorr classifiers, set on a 2¾ slope and operated at 23 strokes per minute.

The classifier sands drop to Nos. 9 and 10 secondary mills, identical in size and characteristics with the primary mills, but operating at 32.5 r.p.m., using 2½-in. balls. The overflow from No. 9 and 10 Dorr classifiers joins the discharges from the secondary mills and is pumped to Nos. 10 and 11 flotation machines. These are two-cell, 24-in. Type-M.S. Sub-A machines, each driven by Tex-rope from a 10-hp. vertical motor. Finished concentrates are produced, which, in the Clarines unit, are sent direct to the filter plant. In the San Francisco unit, this concentrate is

Table I—Screen Analysis, Crusher Plant

MESH	Original Feed, %	No. 2 Symons Feed, Primary, %	No. 2 Symons Discharge, %	Grizzly Undersize, %	No. 3 Symons Feed Secondary %	No. 3 Symons Discharge %	Symons Screen Feed, %	Symons Screen Undersize %	Circulating Load %
+3 in	13.20	15.23	.....	.....	.....	.....	.....	.....	.....
2 in	19.21	27.70	.....	.....	.....	.....	.....	.....	.....
1 in	28.79	30.25	3.80	4.00	8.50	0.80	2.10	.....	.....
¾ in	8.63	11.20	13.50	5.80	31.10	5.00	5.60	.....	.....
½ in	4.84	4.85	20.60	10.70	38.70	30.60	25.60	0.80	79.47
⅜ in	4.53	3.14	20.70	11.80	19.30	22.70	30.80	24.70	71.04
¼ in	3.18	1.93	9.60	10.60	0.60	23.00	10.60	19.60	.....
4	2.29	1.01	5.50	9.10	0.30	5.90	5.10	11.70	.....
6	2.06	0.73	4.80	7.80	0.10	3.00	3.50	7.90	.....
8	1.04	0.34	2.40	3.60	0.04	1.10	1.50	3.40	.....
10	1.85	0.50	3.30	5.70	0.04	1.60	2.30	5.00	.....
14	1.50	0.36	2.30	3.70	0.04	0.90	1.60	3.50	.....
20	1.43	0.31	1.90	3.30	0.02	0.70	1.30	3.00	.....
28	0.59	0.20	1.60	2.80	0.02	0.60	1.10	2.60	.....
35	0.80	0.17	1.50	2.70	0.02	0.60	1.10	2.50	.....
48	0.94	0.24	1.30	2.30	0.06	0.30	0.09	2.10	.....
65	0.48	0.14	0.70	1.40	0.02	0.20	0.05	1.10	.....
100	1.01	0.33	1.40	3.00	0.14	0.70	1.10	2.40	.....
150	0.49	0.18	0.90	1.30	0.08	0.40	0.07	1.50	.....
200	0.43	0.15	0.60	1.50	0.08	0.30	0.04	0.08	.....
—200	2.71	1.04	3.60	8.90	0.84	1.60	4.20	7.40	.....
%	100	78.14	78.14	21.86	75.26	75.26	175.26	100	.....

Crushing rate approximately 90 T/H

Table II—Grinding Efficiency Test, Secondary Crushing Plant

SCREEN		LEVER ARMS		FEED			DISCHARGE		
					Moment			Moment	
Mesh	Openings Min.	Mean Mesh "M"	Mean Surface "S"	% Wt., "W"	Mesh "W" x "M"	Surface "W" x "S"	% Wt., "W"	Mesh "W" x "M"	Surface "W" x "S"
+1	26.67	1	1.00	61.20	61.20	61.20	.....	.....	.....
¾	18.85	2	1.41	8.63	17.26	12.17	.....	.....	.....
—½	13.33	3	2.00	4.84	14.52	9.68	0.80	2.40	1.60
⅜	9.423	4	2.82	4.53	18.12	12.77	24.70	98.80	69.65
3	6.680	5	4.00	3.18	15.90	12.72	19.60	98.00	78.40
4	4.699	6	5.64	2.29	13.74	12.92	11.70	70.20	65.99
6	3.327	7	8.00	2.06	14.42	16.48	7.90	55.30	63.20
8	2.362	8	11.28	1.04	8.32	11.73	3.40	27.20	38.35
10	1.651	9	16.00	1.85	16.65	29.60	5.00	45.00	80.00
14	1.168	10	22.56	1.50	15.00	33.84	3.50	35.00	78.96
20	0.833	11	32.00	1.43	15.73	45.76	3.00	33.00	96.00
28	0.589	12	45.12	0.59	7.08	26.62	2.60	31.20	117.31
35	0.417	13	64.00	0.80	10.40	51.20	2.50	35.20	160.00
48	0.295	14	90.24	0.94	13.16	84.83	2.10	29.40	189.50
65	0.208	15	128.00	0.48	7.20	61.44	1.10	16.50	140.80
100	0.1147	16	180.48	1.01	16.16	182.28	2.40	38.40	433.15
150	0.107	17	256.00	0.49	8.33	125.44	1.50	25.50	384.00
200	0.074	18	360.96	0.43	7.74	155.21	0.08	1.44	28.88
—200	0.074	19	512.00	2.71	51.49	1,387.52	7.40	140.60	3.788.80
—225	0.043	20	721.92	.....	.....	.....	.....	.....	.....
					(x) 332.42	2,333.41		(y) 780.44	5,814.59

(*a*) Mean mesh of feed, 12.06 mm.
(*b*) Mean mesh of discharge, 2.65 mm.
(*c*) Reduction ratio (1.414) $\frac{y-x}{100}$, 4.72.
(*d*) Mean surface of feed, 23.33.
(*e*) Mean surface of discharge, 58.14.
(*f*) Units of surface reduction (*e*—*d*), 34.81.
(*g*) Tons per hour, 90 M. T.
(*h*) Kw. input, 131.
(*i*) Tons per kw. hr., 0.687.
(*j*) Surface tons, per kw. hr. (*f* x *i*), 23.91.

dropped to a Plat-O table to eliminate coarse insoluble, the concentrate being sent to the filter plant and the tailing returned to No. 11 flotation machine.

In the Clarines unit, the tailing from the two-cell flotation machine is passed over five Deister Plat-O tables. This recovers an additional concentrate. Middlings are also made, and treated on a sixth table. Table concentrates join the flotation concentrates. The table tailing is pumped to No. 10 Dorr classifier, set at $2\frac{3}{4}$ slope, making 23 strokes per minute. The sands drop to No. 10 secondary mill, and the overflow constitutes the feed for the main flotation section.

In the San Francisco section, on the other hand, the tailing from the two-cell flotation machine drops directly into No. 13 Dorr classifier, of the same size as the others described, the sands falling to No. 9 secondary mill, the overflow being the feed to the main flotation section of this unit.

Flotation—Flotation is accomplished, in each section, in a 20-cell, 18-in. M. S. Sub-A machine. Sulphide concentrate is taken off the first four cells, sulphidizing reagents are then added, and a concentrate containing sulphidized carbonate lead minerals is taken off the next five cells.

The remaining eleven cells produce middlings, which are sent, in the San Francisco unit, to the table section, and in the Clarines unit to the head of the flotation machine.

Tailings from No. 5 M. S. machine in the Clarines section go to waste, and those from the No. 4 M.S. machine in the San Francisco section are pumped to the five Deister Plat-O tables, where a small additional recovery is made of minerals which are not floated. These table tailings are sent to waste. All concentrate from the San Francisco section is sent to the San Francisco sulphide lead filter plant, and joins the sulphide concentrate for the thickening and filtering.

Concentrate from the Clarines unit is handled in a filter plant, a duplicate of the plant already described, and needs no further comment.

Metallurgy of the Carbonate Sections—Although the term "carbonate ores" is in local use to distinguish them from the ores being treated in the sulphide section, these ores are essentially mixtures of sulphide minerals and numerous alteration products of these same minerals. A list of these minerals is given in Table XII. This is a rather imposing list of minerals, Although it may be a delight to the mineralogist, it becomes a nightmare to the metallurgist.

Both the San Francisco and the Clarines ores contain approximately 60 per cent sulphide and 40 per cent oxidized mineral. The sulphide minerals, with the exception of some of the sphalerite, floated rather well. No trouble is experienced with the cerussite

Table III—Metallurgical Balance from Products

		GOLD		SILVER		LEAD		ZINC		COPPER	
	%Wt.	Gm.	%Wt.	Gm.	%Wt.	%	%Wt.	%	%Wt.	%	%Wt.
Lead concentrates	11.75	9.057	69.47	1,198.8	80.26	58.28	88.73	11.50	24.17	3.38	73.46
Zinc concentrates	5.32	1.000	3.48	168.0	5.10	1.55	1.07	55.80	53.14	0.98	9.56
Tailings	82.93	0.500	27.05	31.0	14.64	0.95	10.20	1.53	22.69	0.11	16.88
Heads	100.	1.532	100.	175.6	100.	7.72	100.	5.59	100.	0.54	100.

METALLURGICAL BALANCE 100%

		GOLD		SILVER		LEAD		ZINC		COPPER	
	%Wt.	Gm.	%Wt.	Gm.	%Wt.	%	%Wt.	%	%Wt.	%	%Wt.
Lead concentrates	10.72	14.29	100.	1,638.1	100.	72.0	100.	.....	.....	5.04	100.
Zinc concentrates	9.02	.....	.....	.....	.....	.....	.....	62.0	100.	.....	.....
Tailings	80.26	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Heads	100.	1.532	100.	175.6	100.	7.72	100.	5.59	100.	0.54	100.

RETURNS FROM LIQUIDATING THE CONCENTRATES

	Lead Concentrates		Zinc Concentrates		Combined Concentrates	
Actual — (per ton ore)	$5.51	78.38%	$0.61	42.47%	$6.13	72.20%
100% (per ton ore)	$7.03		$1.46		$8.49	

Table IV—Minerals in San Francisco Ore and Their Metal Content

	Au	Ag	Pb	Zn	Cu	Fe	As	Fl
Galena	x	x	x					
Sphalerite		x		x	x	x		
Chalcopyrite	x	x			x	x		
Arsenopyrite	x					x	x	
Pyrite						x		
Fluorite								x

Table V—Perfect Separation on Grouping of Minerals in San Francisco Ore

Lead Concentrate		Zinc Concentrate	
Collected	Eliminated	Collected	Eliminated
Galena Chalcopyrite Arsenopyrite	Sphalerite Pyrite Fluorite Calcite Quartz and other gangue minerals	Sphalerite	Remaining lead and copper minerals and arsenopyrite Pyrite Calcite Fluorite Quartz and other gangue minerals

Table VI—Reagents Used

IN LEAD SECTION

At primary mills	60 grams xanthate Z — 3
At secondary mills	300 grams zinc sulphate 70 grams cresylic acid
At feed to lead roughers	10 grams xanthate Z — 3

IN ZINC SECTION

To lead rougher tailing	75 grams sodium carbonate, pH 7 7 310 grams copper sulphate
10-min. agitation with these reagents	
10-min. agitation with this reagent	45 grams sodium cyanide
	10 grams Barrett No. 634 20 grams xanthate Z — 3

Table VII—Average Analysis of Mill Heads, Sulphide Mill, Fiscal Year 1935

Lead	7.21%	Iron	3.44%
Zinc	7.34%	Insol	40.01%
Copper	0.67%	Calcium oxide	5.38%
Gold	0.802 grams	Calcium fluoride	15.39%
Silver	197.7 grams	Sulphur	5.62%

Table VIII—Assays for Fiscal Year 1935

	Lead Concentrate	Zinc Concentrate
Au	4.282 grams	0.916 grams
Ag	1,268.80 grams	182.0 grams
Pb	52.22%	1.64%
Zn	13.76%	54.74%
Cu	3.88%	1.14%
Fe	5.78%	6.88%
Insol	1.23%	1.18%
CaO	0.28%	0.26%
S	19.33%	29.80%
As	0.43%	0.34%
Bi	0.097%	.....
Cd	.....	0.21%
CaF_2	.....	0.22%

Table IX—Screen Analysis Fiscal Year 1935

Mesh	Primary Mill Disch.	Flotation Feed	Mill Tailing
	%	%	%
+20	5.40	.....	.....
28	7.18	.....	.....
35	9.37	3.47	4.75
48	9.52	5.62	7.51
65	7.00	5.72	7.27
100	12.58	13.78	16.32
150	6.87	8.88	9.03
200	5.96	7.93	7.38
—200	36.12	54.60	47.44

Table X—Mill Labor Data and Costs

(Fiscal Year, 1935, Mexican Currency)

	No. Man-Shifts	Total Costs	No. Men per Day	Cost per Day	Ave. Wage per Man	%Total Cost	Tons per Man	Cost per Ton (2—1)	
A—Mill	21,195	$76,362.28	58.55	$210.94	$3.60	47.18	.....	0.170	0.094
B—Mechanics	5,282	24,672.67	14.59	68.16	4.67	15.25	.....	0.055	0.030
C—Surface	15,695	44,975.32	43.36	124.24	2.87	27.79	.....	0.101	0.058
Assay office	2,922	10,191.36	8.07	28.15	3.49	6.30	.....	0.023	0.012
Sample room	1,593	5,632.25	4.40	15.56	3.54	3.48	.....	0.013	0.008
Totals	46,687	161,833.88	128.97	447.05	3.47	100.00	7.628	0.362	0.202
Total A-B-C	42,172	146,010.27	116.50	403.34	3.46	90.22	8.444	0.326	0.182

Table XI—Milling Costs Per Ton

(Mexican Currency 2:1)

	Primary Crushing	Sec Crushing	Grinding Tables	Flotation	Reagent	Filter	Tailings	Water	Metallurgical Research	Assay	Overhead	Miscellaneous	Total
Supplies	0.010	0.051	0.251	0.047	0.342	0.019	0.012	0.008	.....	....	....	0.018	0.758
Power	0.008	0.026	0.295	0.215	.....	0.019	0.019	0.018	.....	....	....	0.012	0.612
Labor bosses	0.025	0.025	0.048	0.068	.....	0.011	0.024	0.008	0.007	....	0.102	0.019	0.337
Shops	.....	.....	.....	.....	.....	.....	.....	.....	.....	....	....	0.012	0.012
Miscellaneous	0.002	0.001	0.004	0.005	.....	0.001	0.14	0.001	.....	....	....	0.043	0.071
Assay	.....	.....	.....	.....	.....	.....	.....	.....	0.007	0.070	....	....	0.077
Total	0.045	0.103	0.598	0.677	.....	0.050	0.069	0.035	0.14	0.070	0.102	0.104	1.867

United States Currency, $0.9335

Table XII—Most Common Minerals in "Carbonate" or Oxidized Ores

San Francisco Oxidized Ores	Clarines Oxidized ores
Galena	Galena
Sphalerite	Sphalerite
Pyrite	Pyrite
Chalcopyrite	Chalcopyrite
Arsenopyrite	Arsenopyrite
Cerussite	Cerussite
Anglesite	Anglesite
Pyromorphite	———
Mimetite	———
Vanadinite	———
Wulfenite	———
Jarosite	———
Malachite and azurite	Malachite and azurite
Smithsonite	Smithsonite
Hematite	Hematite
Calcite	Calcite
Fluorite	Fluorite
Quartz	Quartz
Shale from walls	Shale from walls
Native gold	Native gold
Native silver	Native silver
———	Native copper

Table XIII—Average Analysis of Oxidized Ores, Period March, 1935, to April, 1936

	San Francisco Carbonates	Clarines Carbonates
MILL FEED		
Au	2.573 grams	6.246 grams
Ag	259.290 grams	84.860 grams
Pb	4.30%	2.96%
Zn	3.53%	3.48%
Cu	0.326%	0.50%
Concentrates		
Au	13.810 grams	48.047 grams
Ag	1,350.50 grams	646.03 grams
Pb	27.29%	24.97%
Zn	16.72%	17.72%
Cu	1.58%	3.36%

Table XIV—Reagents Used

	San Francisco Section Kg. per Ton	Clarines Section Kg. per Ton
Heavy oil, at primary mill	0.550	0.830
Xanthate Z-3	0.175	0.130
Cleveland-Cliffs creosote at flotation roughers	0.030	0.060
Sodium sulphide—fifth cell	2.500	2.500
Sodium silicate—fifth cell	0.650	0.600

or with the native gold and native silver when bright. A considerable portion of the native gold floated is minus 300 mesh. Most of the other economic minerals—and they all carry the precious metals in appreciable amounts—prefer a final resting place in the tailings dams, rather than to suffer the tortures of the lead furnace.

In both groups of ores, although more noticeably in those of the Clarines, the metallic gold, from the largest size particles, about 0.208 mm., to the very fine, presents two appearances under the microscope. In one, there is the characteristic bright golden color, somewhat light, as the gold is only 680 fine. In the other, the metal is coated, presenting, at one extreme, a very light iridescent tarnish; at the other a jet-black coating. In fact, the metal would hardly be recognized as gold by one not acquainted with the ore, except possibly by the shape of some of the particles.

The bright gold floats rather well; the black coated gold with difficulty or not at all. An acid or alkaline wash removes some of the coating, probably iron oxide. In some instances this is not effective, but the coating is removed by annealing, which might indicate an allotrope. Whatever it is, it causes trouble in recovery, and argues for some method in addition to flotation. This is being investigated.

In the San Francisco carbonates, the odd lead minerals are quite fine and are not liberated to any extent in the primary mills. They are all much more brittle than the gangue, and after passing through the secondary mills, although free, are, for the greater part, minus 325 mesh. These points of difference are brought out, as they will explain the difference in the flowsheets of the two sections.

In both sections, after passing the primary mills, the pulp is pumped to a Dorr classifier, which is in closed circuit with the secondary grinding mill.

The primary classifier overflow plus the secondary mill discharge is floated in two 24-in. M.S. cells. In San Francisco practice the tailing from the flotation cells is dropped into a finishing classifier, the sands going to the secondary mill, the overflow being the feed for the main flotation section. The concentrates from the flotation cells are tabled on a Deister Plat-O table to eliminate a small quantity of coarse insoluble, raised by the heavy oil used. The table tailing, practically all head water, joins the secondary mill discharge, forming a circulating load through the M.S. cells. By doing this, a much more consistent, uniform froth is maintained on the cells.

On the Clarines ores, the tailing from the two flotation cells is treated on a series of Deister Plat-O tables, to recover metallic gold which has not floated, the table tailings being sent to a finishing classifier in closed circuit with the secondary mill. With this set-up, the secondary mill circulating load is being floated and tabled continuously. The concentrate from the two flotation cells would be tabled as in the San Francisco section, but the temptation for theft would be too great, inasmuch as at times a rather broad band of metallic gold would appear. It has been tried.

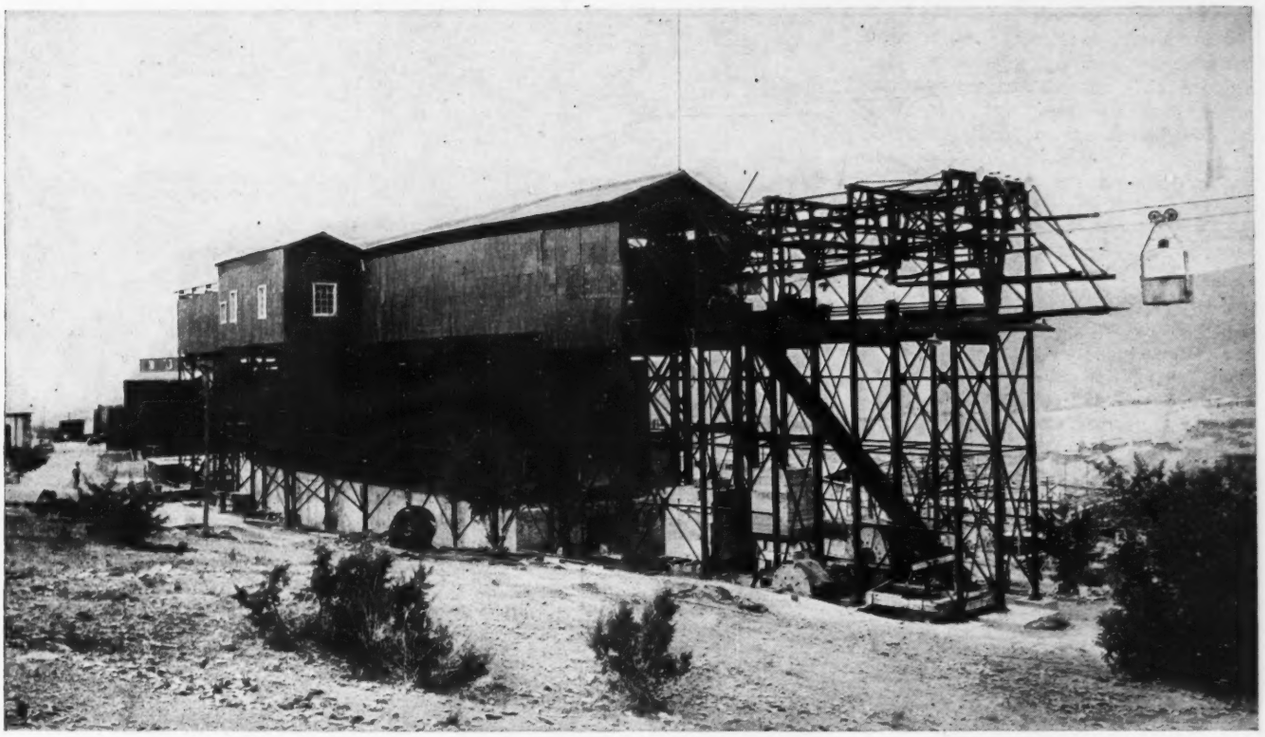
The overflow of the finishing classifier is feed for a 20-cell, 18-in. M.S. Sub-A flotation machine. The first four cells are operated as "sulphide cells" to give another chance for any metallic gold to float before adding the sodium sulphide, one of the carbonate reagents, which has an inhibiting effect on metallic gold. The conditioning reagents for the carbonate minerals are added at the fifth cell, five cells of sulphidized minerals taken off, and eleven cells of middling returned, in the San Francisco section, to the secondary grinding circuit; in the Clarines, to the head of the 20-cell flotation machine.

The San Francisco flotation tailings are tabled on a series of Deister Plat-O tables, to recover what may be of the odd lead minerals which do not respond to flotation. Clarines flotation tailings are sent to waste.

Flotation concentrates are not cleaned. All concentrates are gathered at one place in each section and are pumped to the filter plant. San Francisco carbonate concentrate is filtered with San Francisco sulphide concentrate.

Flotation feed is approximately 35 per cent solids and will average 52 per cent minus 200 mesh. The pH is about 9.0 after Na_2S has been added.

Tailing Disposal — Final tailings from the different sections are conveyed to one point through individual 8x12-in. launders, sampled, and run to the tailings dams, a distance of approximately 500 m. Launders from the mill to the pumping units at the dam are lined with white-iron liners.



MILL TERMINAL at San Francisco del Oro of aërial tramway system which serves for transporting ores from San Francisco and Clarines mine units and the intermediate La Mesa unit to the concentrator

The present dams contain about 2,500,000 tons and have almost reached their storage capacity.

Advantage can no longer be had of a gravity flow, so all tailings are now elevated 30 ft. by 6-in. Wilfley pumps. Three pumps are kept in order at this pumping plant. Sometimes one, sometimes two, are in use, depending on whether or not the tailings are being segregated, and a third is always ready.

The pulp is distributed around the periphery of the dam by launders in the usual manner, the tailing dropping through 1½-in. holes, spaced 6 ft. apart, in the bottom of the launders.

The present dam is divided into five sections, providing ample time for settling and building up the edges, which is done by shoveling.

As return water is needed at the mill, it is drawn off the far side of the dams and run to a sump, from which it is returned by a 9x12-in. Goulds vertical triplex plunger pump, operating against a total pressure of 130 lb.

When the dams are filled up to the distributing launders, these are raised 16 ft. and set in 16 ft., forming the slope for additional height.

A new dam is in process of construction, about one mile below the mill, and when completed it will provide storage room for 12,000,000 tons, or for 20 years at the present milling rate.

Water Supply—All fresh water for milling is pumped from the mine, approximately 500 g.p.m. This is run through a 10-in. pipe line approximately 1½ miles long to a fresh-water storage *pila* above the mill. This is a circular concrete reservoir, with a capacity of 450,000 gal. From this, water is drawn for all uses except drinking. It supplies service water for the different units of the camp in addition to that used in milling.

Water is reclaimed from all Dorr thickeners and is pumped through the mill circuits, with two steel tanks of 50,000 gal. each, and one of 9,000 gal., serving as steady-head tanks.

Pumping is done by one 5⅞-in. triplex Tex-rope driven pump, one 8x10-in. triplex, one 6x8-in. belted triplex, and one six-stage Allis-Chalmers centrifugal pump, if needed.

A square masonry *pila* of 450,000-gal. capacity, located at the foot of the mill, serves as a catch basin for all water in excess of that being pumped through the mill. It also receives the overflow of the fresh water *pila*, if any, and serves as storage for return water pumped from the tailing dams. This water is returned by a 9x12-in. triplex belt-driven pump.

In addition to this, there is a 900,000-gal. masonry rectangular *pila* at the foot of the mill, which receives and stores reclaimed water from the tailing dam. This water is returned to the system as needed by two 3-in. centrifugal Cameron pumps.

The total storage capacity for fresh water is 450,000 gal.; for return water, about 1,600,000 gal.

Total water used in milling is approximately 4 tons for each ton of ore, or 1,050 g.p.m., of which 400 g.p.m. is fresh water, 300 g.p.m. is return water from the tailings dam, and 300 g.p.m. is circulated in the mill.

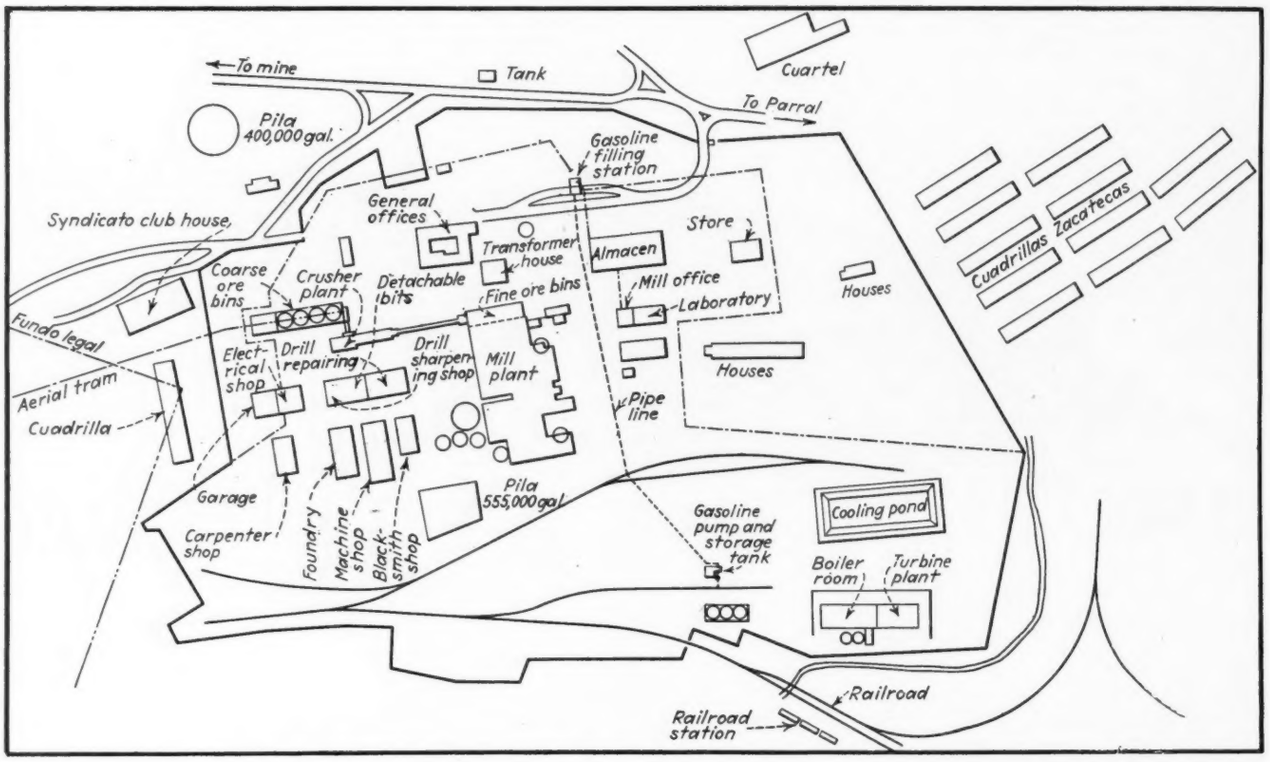
The pH of the fresh water is 7.6; that of the return water is 7.8. Both classes are used indiscriminately, as no difficulty has ever been experienced in any respect due to the small amounts of reagents which are present in the return water.

Assaying — A two-story fireproof building houses the laboratory and assay office, as well as the office of the mill superintendent and the general mill offices. The personnel consists of a chief chemist, H. F. Strobel, and a force of twelve men. Working eight hours a day for six days a week, they make approximately 20,000 determinations a month at an average cost of 10c. each (United States currency).

A testing laboratory is provided under the supervision of Clark J. Parker.

Labor — Mill operations are continuous on three shifts of eight hours each. In addition to the superintendent and T. R. Herndon, assistant, the foreign staff includes a mill foreman, Joe Lane, in direct charge of the mechanical operation; a flotation foreman, Walter R. Conn, responsible for the current metallurgical operation; and three foremen, one on each shift of eight hours.

The crew consists of 75 man-shifts per day on operation, covering three shifts; 22 man-shifts on the repair crew; 60 man-shifts on the surface, and 5 man-shifts in the sample room.



LAYOUT WITHIN THE HACIENDA

A plan showing the location of the mill and of the new shops grouped just south of the concentrator. Outside of the wall to the north lies "Zacatecas," the name given to one group of Mexican living quarters. A new club house for the members of the miners' union is being built just outside the walls at the south end of the hacienda

Mechanical Operations Centralized

Modern Drill Repair and Bit Sharpening Shop Prepares for Expanded Program

L. C. Overton
Mechanical Superintendent

EQUIPMENT to supply the mechanical requirements of a large mining company in remote Mexico must be diversified and complete, to help maintain efficiency in the mining, milling, and allied operations. The mechanical department of the San Francisco Mines of Mexico began operations in a small machine shop alongside the mill twelve years ago. As mining operations steadily increased through the years, this department required more space, and consequently small additions of the lean-to type now project from the walls of the mill.

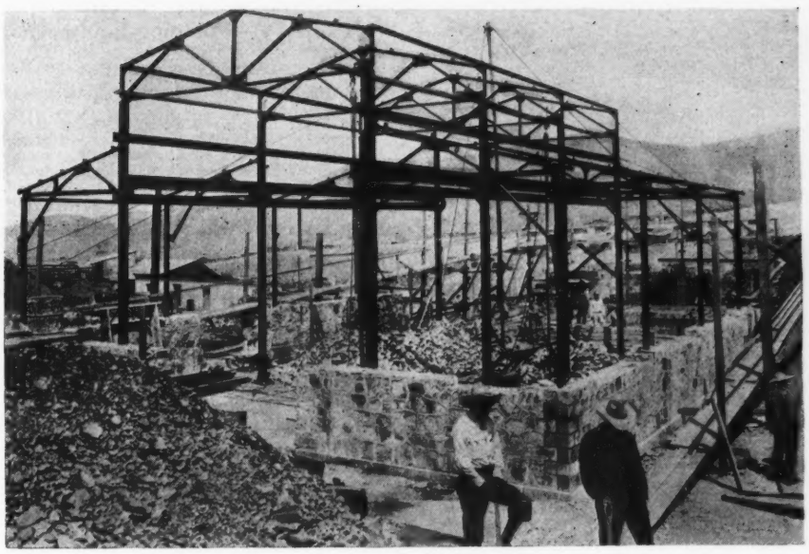
The present program of expansion by the company includes a new steel, stone, and adobe brick building, which will house the new machine shop, and will also include a garage and service station, which when completed will be one of the most modern in Mexico. A blacksmith shop adjoining the new machine shop is now nearing completion. A foundry is being designed to be erected later. These modern buildings, with new machines and equipment to be added, will then provide facilities commensurate with the objective of mining and milling 2,000 tons of ore a day. Two divisions of this department are now functioning in the new building; namely, the carpenter shop and detachable-bit and drill-repair shop.

Remoteness from manufacturing centers plus import duties force the management to fortify itself with machinery so as to manufacture small replacement parts such as for pumps, rock-drill spares, pistons, valves, dies and dollies for the drill sharpeners, mine skips, cages, dumping rails, ore feeders, and numerous other items.

At present about 38 men are employed in the machine shop at the hacienda, operating on two shifts. At the San Francisco mine there are 24 Mexicans whose duties involve the care of large and small pumps, air compressors, and main air lines in shafts and levels; also welding, blacksmithing, hoist and mine car repairs, and similar work. At the Clarines unit 20 men are caring for mechanical upkeep and installation of equipment. The new El Toro unit has two mechanics, three pump men, and three compressor men, but this staff will increase when the new Ottumwa hoist, new headframe, and Jeffrey conveyor system are installed.

Hacienda Machine Shop—The new hacienda machine shop is the largest of the new buildings now nearing completion. It measures 50 ft. wide and 115 ft. long, and will have an office connection at the west end leading into a new blacksmith shop, which measures 30 ft. wide and 32 ft. long. Thirty-eight men will be employed on two shifts in the machine shop. Equipment and machines are listed in Table I.

All this equipment will be placed in the new shop, and those machines which have formerly been belt-driven will be converted into individual V-belt type motor drives. This change has



GROWING FRAMEWORK of the new machine shop, which will have under the floor at the far end a modern garage and service station. The foundation wall is 5 ft. high, consisting of rhyolite boulders blasted from a nearby dike and hauled by burros. The corner stones are of concrete and are made in a plant on the property. Above the foundation wall, adobe bricks will be used, affording good insulation against heat or cold

"ADOBE ENGINEERS," feet first in their work, knead the red-colored dirt, mixed with water and straw, making a product which is poured into wooden molds and dried in the sun. White spots on the completed bricks show they have beeen counted. Eight men can prepare and make 600 adobes per eight-hour day

been gradual, but will be complete when operating in the new shop. Each of the mine units maintains equipment for general repairs only and all other mechanical work will be done at the central machine shop. The maintenance of good roads to the various mine units permits trucks to transport broken parts quickly to the central machine shop and back to the job.

Mechanical equipment at all the units is under the supervision of Willard Edmondson, who is the mine master mechanic. At the San Francisco, Clarines, and El Toro units, Mexicans operate the compressors and hoists. Underground, the pump men are Mexicans, and a skeleton staff of utility mechanics follow a routine of checking and maintaining surface and underground equipment at the various mines.

At the Clarines unit there are twenty men under the supervision of the mechanical department. At present La Mesa unit has two mechanics, three pump men, and three compressor men. Sixteen men are employed to operate the primary crushers and conveyors located at the shafts.

Detachable-Bit Shop—Use of detachable bits has increased steadily at the San Francisco Mines, and at present about 80 per cent of the bits used are of this type. Eventually, detachable bits will be used altogether, thereby eliminating rod drill steel, except for hand-rotated stopers at the San Francisco mine. The other mines use self-rotating stopers. A new building was recently erected for the sharpening of detachable bits and for drill repair. The equipment in the detachable drill shop is listed in Table II.

All equipment in the shop at the San Francisco mine will be moved to the central shop during the last quarter of the year.

Men in the sharpening shop generally work in pairs. One will sharpen bits and the other will grind the gage. Their base pay is 3.25 pesos per day, but, work being on a contract basis, each bit sharpened nets 3 centavos and the number sharpened above the equivalent for the base earns a bonus.

At present about 35,000 bits are sharpened monthly. Types of bits used are Ingersoll-Rand Jackbit Type 1 and Timken Type B. Type D has recently been added. This number will

Table I—Hacienda Machine-Shop Equipment

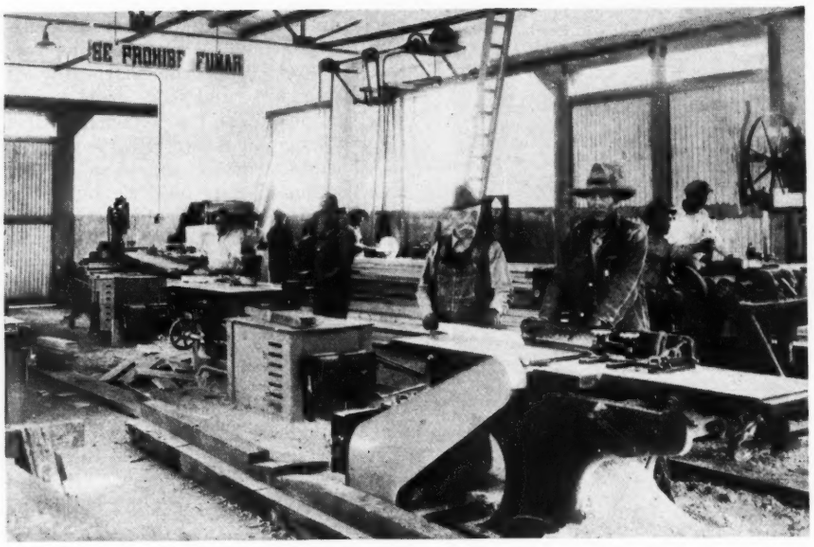
1 McCabe double-spindle 48-in. lathe
1 18-in. x 5-ft. American lathe
1 18-in. x 16-in. Champion lathe
1 32-in. Eberhardts shaper
1 18-in. Superior drill press
1 30-in. Stoever pipe-threading machine built by Treadwell Engineering Company, Easton, Pa.
1 1½-in. Landis threading machiine
1 Sensitive drill press
1 800-lb. Niles-Bement-Pond Company air hammer
1 250-ton hydraulic press
1 4½-ft. Williams, White & Company punch and shear machine
1 Metal Spray gun by Metal Spray Company

Table II—Equipment in Detachable-Bit Shop

3 Ingersoll-Rand J-2 Jackbit sharpeners
1 Massco rockbit grinder
1 Worthington automatic Type 5 diesel oil furnace for tempering drill rods equipped with a Brown electric pyrometer
1 Root-Connersville blower, capacity 0.75 cu.ft. displacement per revolution
1 Allis-Chalmers 5-hp. induction motor for driving blower
1 Gardner-Denver Model 6 drill sharpener
1 Hisey two-wheel grinding machine
1 Toledo threading machine, No. 1000 M., for threading rods for detachable bits
1 Annealing furnace for detachable bits
1 Furnace for tempering stoper steel
3 Ingersoll-Rand sharpeners, No. 5
1 Gardner-Denver sharpener, No. 8

Table III—Rock Drills in Use

Sinking Machines	No.	Where Used
S-55 Gardner-Denver	13	All at Clarines—general use
S-68 Ingersoll-Rand	1	San Francisco
CP-42 Chicago Pneumatic	5	El Toro
CP-10 Chicago Pneumatic	3	El Toro
L-9 Sullivan	6	San Francisco
CP-5 Chicago Pneumatic	5	Guerrero Shaft
CP-52 Chicago Pneumatic	9	San Francisco
X-59 Ingersoll-Rand	2	Guerrero Shaft
L-12 Sullivan	12	Las Mesa Shaft
H-77 Cleveland	3	Clarines
Stoping Machines		
H-81 Gardner-Denver	18	San Francisco
N-79 Ingersoll-Rand	47	San Francisco
S-17 Cleveland	38	Clarines
Drifters		
CP-50 Chicago Pneumatic	4	Clarines
R-72 Ingersoll-Rand	5	San Francisco
D-89 Gardner-Denver	24	12 at San Francisco, 12 at Clarines
D-12 Cleveland	26	13 at San Francisco, 13 at Clarines
T-10 Sullivan	11	San Francisco and El Toro
CP-60 Chicago Pneumatic	26	San Francisco
D-99 Gardner-Denver	2	Heavy-duty 7-m. holes, San Francisco



"NO SMOKING ALLOWED" says the sign in the new carpenter shop, where the elderly "maestro carpintero" supervises the work of eight men

Table IV—Pumping Equipment

SAN FRANCISCO MINE

North Shaft Level 4—1 Smith Vaile triplex, 176 g.p.m.
North Shaft Level 7—2 Prescott-Menominee, 600 g.p.m., 1 6-stage Allis-Chalmers, 300 g.p.m.
North Shaft Level 8—1 Cameron, 1,000 g.p.m.
North Shaft Level 9—1 Prescott-Menominee, 600 g.p.m., 1 Cameron, 1,000 g.p.m.
North Shaft Level in shaft—1 No. 6 Cameron air sinker
South Shaft Level 10—1 Allis-Chalmers automatic, 200 g.p.m.
South Shaft in shaft—1 Cameron automatic, 250 g.p.m.
South Shaft extra—1 Cameron electric sinker, 250 g.p.m.

EL TORO MINE

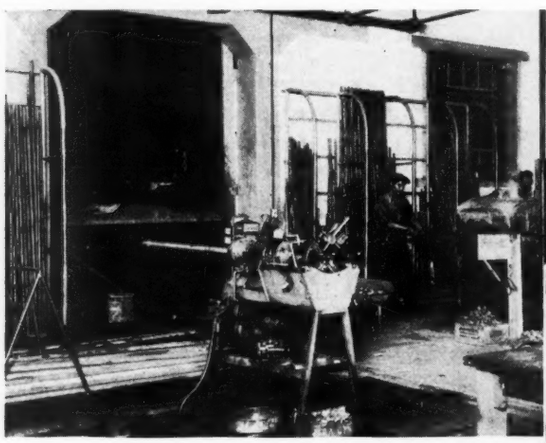
Main haulage level—1 Gould's triplex, 100 g.p.m.
Richards winze—1 Cameron automatic, 250 g.p.m. 1 No. 3 Cameron sinker

CLARINES

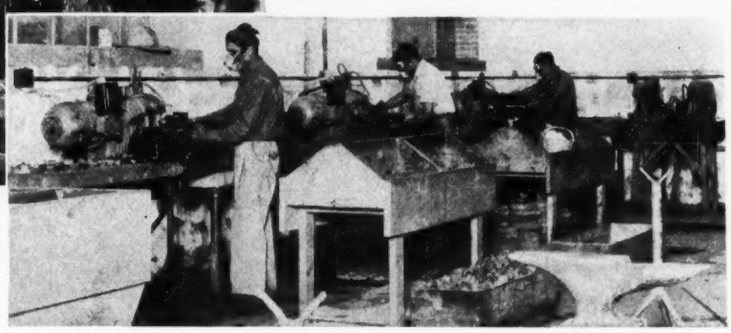
Level 3—1 Cameron centrifugal, 500 g.p.m.
Level 4—1 Aldrich triplex, 450 g.p.m., 2 of 250 g.p.m., 1 Allis-Chalmers, 6-stage centrifugal
In shaft—1 Cameron centrifugal, 500 g.p.m.
In winze—1 No. 3 Cameron sinker
Extra—1 Cameron electric sinker, 300 g.p.m.

Table V—Hoists

San Francisco Mine, North Shaft—1 225-hp. double-drum Lincoln winding engine
San Francisco Mine, South Shaft—1 150-hp. double-drum Ottumwa hoist
Clarines Mine, Remedias Shaft—1 125-hp. double-drum Ottumwa hoist
Clarines Mine, Reforma Shaft—1 80-hp. double-drum Ottumwa hoist
El Toro Mine, San Jose Shaft—1 150-hp. double-drum Ottumwa hoist
El Toro Mine, La Mesa Shaft—1 225-hp. double-drum Ottumwa hoist
San Francisco Mine, South Shaft—1 40-hp. single drum Ottumwa hoist, operating from 10 to 7 level hoisting waste in third compartment of shaft.



A CORNER OF THE DRILL-SHARPENING SHOP recently completed at the hacienda. Ample space remains in this building for the transfer of sharpening equipment from the North Shaft. This affords centralization of drill steel work for all units. The furnace and machine on the right is for stoper steel and the machine in the center is for threading rods used for detachable bits. The attendant at the left of the small furnace observes the proper heating of detachable bits



SHARPENING DETACHABLE BITS. Goggles and respirators are used by the men who do this work, which is on a bonus system. The men usually work in teams, one grinding and the other gaging the bits

increase when operations start at El Toro. Each new bit is sharpened four times on an average before it is discarded. Issuance of new bits each month amounts to about 15,000. When the drill-sharpening equipment from the North Shaft is brought to the new shop in the hacienda and equipment added for broader research on detachable-bit sharpening, all mechanical operations will be centralized and sharpening technique improved. Numerous tests are being made under the supervision of Samuel Titus, drillshop foreman. A No. 4 M Rockwell hardness tester, 12-in. vertical capacity, is installed for the purpose of determining the proper bit hardness. Tests will be broken down to determine the best heat and brine treatments for bits used in the various mines where rock conditions demand certain requirements of sharpened bits.

Re-threading of rods is done on a Toledo re-threading machine and tempered in a Worthington No. 5 automatic furnace. A Brown electric pyrometer indicates and maintains proper temperature in the furnace. Concentration of research in the new drill-repair and sharpening shop will provide facts that will indicate how efficient de-

Table VI—Compressors

Manufacturer	No.	Capacity C.F.M.	HP. Motor	Maker
San Francisco, Chicago Pneumatic	1	5,000	800	General Electric
Clarines, Chicago Pneumatic	1	3,000	500	Allis-Chalmers
San Francisco, Worthington	1	2,000	400	General Electric
San Francisco, Worthington	2 at 1,050	2,000	350	Westinghouse
La Mesa, Worthington	1	2,100	155	General Electric
Clarines, Worthington	1	1,275	210	Westinghouse
San Francisco, Ingersoll-Rand	1	1,250	210	General Electric
La Mesa, Gardner-Denver	1	640	125	General Electric
Total capacity		17,265		

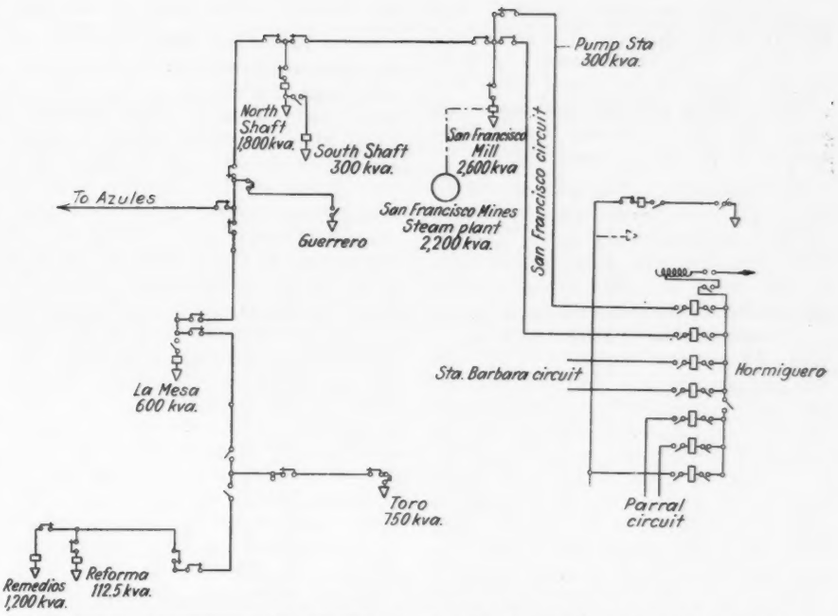
tachable bits are at the San Francisco Mines of Mexico. Service men from the various drill and bit manufacturers frequently visit the shops and cooperate with the company in obtaining a higher efficiency in this work. Drill steel used is Hadfields', made in England.

Automobile Repair—Maintenance of all trucks and automobiles comes under the mechanical department. There are seven Ford V-8 pick-up cars; three Ford V-8 station wagons, one 1½-ton Ford V-8 truck; one 2½-ton Ford V-8 truck; two Ford sedans; one 5-ton White truck; and one Buick straight-eight sedan. At present there are four auto repair men. Underneath the new machine shop, now nearing completion, will be one of the most modern garages and service stations in Northern Mexico, fully equipped for any type of automobile repair.

Electric Welding—The practice of electric welding is applied at these mines with great advantage. Availability of current and experienced Mexican welders using American welding equipment and supplies have helped considerably in reducing the cost of repair jobs which formerly were performed by other methods of repair. Acetylene welding is also used advantageously, by experienced Mexican welders. Oxygen and acetylene are supplied from Monterrey, Mexico. Torches and gages, however, are all purchased from American manufacturers. All electric welding equipment is portable and is generally kept near the central machine shop. All the mine units have acetylene welding equipment for general repairs and cutting purposes.

Carpenter Shop—All woodwork and timber framing were formerly done in a small building, but the present serviceable, newly built shop, modern in all respects, is now available for such services. The building is well lighted and has a framework of steel surrounded by adobe bricks, the outside of which are covered with white stucco cement. All the machines in the carpenter shop are equipped with individual-motor V-belt type drives. Mine timber sets are made here; also ladders for all the mines except those used in the North Shaft, which are made there. Texas pine is used for shaft sets and guides. All types of woodworking are performed in this shop. Products made include doors, window frames, tool boxes, and occasional office furniture such as tables, desks, and files.

The spreading out of mine operations forces an increase in mechanical equipment and care in its upkeep. The company's policy of making capital investments in mechanical equipment which promotes efficiency and lowers operating costs makes it possible to look forward to the 2,000-ton per day operation with a minimum of expense in mechanical upkeep.



POWER DISTRIBUTION CHART, showing the distribution of electric power to the various units and substations of the San Francisco company as effected from the Hormiguero central station of the Rio Conchos Power Company (Cia. Agricola y de Fuerza Electrica del Rio Conchos)

Electric Power

Consumed Monthly Is 2,250,000 Kw.-hr.

Six Substations Serve the Property

W. E. Mashburn
Superintendent of Electrical Department

BOTH hydro-electric and thermal power are purchased from the Cía. Agricola y de Fuerza Eléctrica del Rio Conchos, S. A. The main source of power is the hydro-electric plant at Boquilla, which with two other hydro-electric plants, Colima and Rosetilla, located farther down the Rio Conchos, is tied in with the Francke steam plant at Torreon. From Boquilla the power is transmitted to Hormiguero substation at 110,000 volts, where it is stepped down to 13,000 volts; from there it is distributed to the mines in the Santa Barbara-San Francisco del Oro district.

Service, on the whole, has been satisfactory. However, in the rainy seasons we are subjected to occasional interruptions caused by lightning.

During 1928, '29, and '30 (before the steam plant was built in Torreon) the power company was unable to supply sufficient power, due to several years of very light rainfall. When the rainy season (July and August) of 1928 failed to put any appreciable amount of water in the Boquilla dam, and the winter rains did not materialize, it became evident that something had to be done if we were to have enough power to operate the plant for the coming year. Decision was made to move the 2,000-kw. plant, which the company owned at its La Fe property in Zacatecas, to San Francisco Mines. Engineering work was started on the power plant site March 1, but progress was slow and actual dismantling in La Fe was not started until May 8. The construction was nearly finished and the plant placed in operation on Nov. 30. Total elapsed time was nine months, but actually the work was done in less than eight months. This plant was run at practically full capacity until March 27, 1931, at which time the power company, having put its Torreon steam plant in operating condition, was able again to supply our power demands.

Table I shows the eight receiving stations through which power is supplied to the company, as well as the connected load in transformers and motors.

The monthly consumption of power averages around 2¼ million kw.-hr. and is used in about the following proportions: Mining, 42 per cent; milling, 55 per cent; and miscellaneous, including shops, hotels, dwellings, and incidental purposes, 3 per cent.

Established maximum demand rose rapidly from February, 1935, to the end of April, 1936. The demand will be further increased by about 1,000 kw. when La Mesa and San Jose shafts are ready for operations and the El Toro section of the mill is completed.

Mill Substation—The mill substation supplies power stepped down, by three 667-kva. and three 200-kva. Westinghouse transformers, from 13,200 volts to 480 volts, for the various milling operations, shops, and dwellings.

To maintain the power factor at or above 85 per cent, we have in use five synchronous motors. Magnetic clutches are used on the 100-hp. Allis-Chalmers unit driving the No. 5 rod mill and the 150-hp. Westinghouse unit driving No. 6 rod mill, in order to take care of the heavy starting load. The 48-in. Symons cone crusher is driven through a V-belt by a 160-hp. Westinghouse synchronous motor, and no trouble is encountered in starting. The other two synchronous motors are G.E. 185-hp. and 200-hp. machines, which drive, through belts and line shaft clutches, the battery of Roots blowers. The rest of the load is taken by induction motors of various makes and sizes from 1/6 to 125 hp.

Power is transmitted over sixteen circuits through a tunnel from the substation to the mill. Each circuit is metered at the substation switchboard to facilitate the subdivision of power to the various mill operating accounts.

Mine Substation—Power coming into this substation supplies both the North and South shafts and is metered in the same way as at the mill substation. That from the North Shaft is stepped down from 13,200 volts to 480 volts by three banks of three 200-kva. Westinghouse transformers. From the low-tension switchboard it is metered out over ten circuits to the various mining operations at the North Shaft. The largest motor on the property, an 800-hp. G.E. synchronous unit, is direct-connected to a 5,000-cu.ft. Chicago Pneumatic compressor. This motor is started by manually closing a 2,000-amp. oil circuit breaker, after which the machine is automatically brought up to speed, and the excitation applied, without any appreciable shock on the line. Three other compressors are direct-connected to synchronous motors of 210, 350, and 400-hp. capacities.

Three 600-g.p.m. Prescott station pumps are direct-connected to 225-hp. Westinghouse wound-rotor induction motors with special moisture-proof windings which have never given any trouble in the ten years of operation.

Five circuits which supply current to the pumps and other underground motors are of 3-phase 600-volt lead-and-steel armored cable of 500,000- and 300,000-circ.mil area, sectionalized, and are brought out on busses on the fourth, sixth, seventh, eighth, and ninth levels, thus enabling us to isolate quickly any section of cable for inspection or repair.

The main hoist at the North Shaft is direct-connected through a flexible coupling to a 225-hp. G.E. motor which is controlled in the usual way through a master controller and clapper switches.

Power to the South Shaft is metered at the North Shaft receiving station and transmitted over our own 13,200-volt lines to the South Shaft substation, a distance of about 900 m., where it is stepped down to 480 volts through a bank of three 100-kva. single-phase Westinghouse transformers. Power is supplied from this station through induction motors for hoisting, crushing, tramming, and pumping.

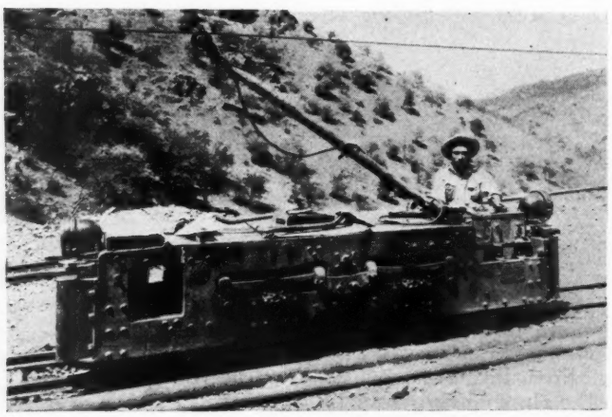
Ore is transferred from the South Shaft to the North Shaft on the No. 1 level by two 3-ton Atlas storage-battery locomotives, equipped with 80 A8 Edison cells. The batteries are serviced at the charging station at the North Shaft, which is equipped with motor-generator sets and fully automatic charging panels.

The six Mancha trammers used underground are each equipped with 40 A45 Edison cells, with charging stations on the eighth level, South Shaft, and ninth level, North Shaft. These stations each have two 7½-kw. motor-generator sets and fully automatic charging panels.

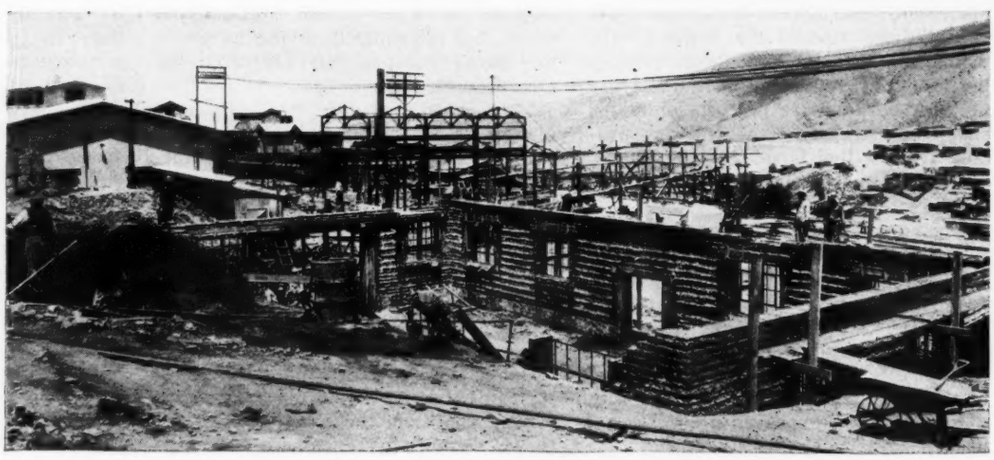
Guerrero Receiving Station—The power at this station is stepped down from 13,200 volts to 480 volts through three 50 kva. Westinghouse single-phase transformers and is metered on the secondary side of the transformers. Power is supplied to a 75-hp. Westinghouse motor geared to a Sullivan hoist.

La Mesa Substation—The power company delivers the power to us over a looped-in circuit through outdoor metering equipment located in the terminal tower. It is received through our own high-tension switch and panel, on which is mounted our Type RA recording-demand watt-hour meter.

Three 200-kva. Westinghouse single-



THIS TROLLEY LOCOMOTIVE hauls ore in El Toro Tunnel, in trains of 15 cars of 800 kg. capacity each. The speed is 6 m.p.h., the voltage 250, and the drawbar pull is rated at 1,600 pounds.



CONSTRUCTION ACTIVITY in the hacienda as it appeared recently. The adobe building with the steel window frames that is being erected is the now-completed electrical shop. Beyond is seen the new machine shop as it appeared when the photograph was taken

Table I—Connected Load

Receiving Station	Kva. Transf. 13200/400	Motor Hp. Induction	Motor Hp. Synchr.	Lighting Trans. Kva.	Equiv. Hp.	Equiv. Kva.	No. Motors	Watt-hour Meters	Graphic Meters	Indictg. Instr.
Mill	2,600	3,345½	795	247½	4,472	3,336	210	34	4	56
San Francisco line	2,100	1,995	1,760	35	3,802	2,836	46	31	1	68
Guerrero	150	75	.....	5	82	61	1	1	..	..
La Mesa	600	112½	310	5	429	320	7	5	1	11
El Toro	750	140	125	10	207	207	6	1	..	8
Reforma	112½	105	.....	5	112	84	2	1	1	3
Remedios	1,200	575	710	15	1,305	974	21	7	1	12
Tailings dam	300	100	.....	6½	109	81	1	1	..	2
Totals	7,812½	6,448	3,700	329	10,589	7,899	294	81	8	160

Table II—Power Summary

		MINES		MILL		MISCELLANEOUS		TOTAL		Connected Load	
Year (a)	Tons Milled (b)	Kw. Hr.	Kw. Hr. per Ton	Kw. Hr.	Kw. Hr. per Ton	Kw. Hr.	Kw. Hr. per Ton	Kw. Hr.	Kw. Hr. per Ton	Kw. Transfrmr.	2-Hp. Motors
1924	133,590	2,832,290	21.2	4,368,063	32.7	201,577	1.5	7,401,930	55.4	1,500	2,180
1925	148,580	4,859,162	32.7	4,885,884	32.9	402,518	2.7	10,147,564	68.3	2,100	.....
1926	205,060	5,153,160	25.1	7,039,387	34.3	473,189	2.3	12,665,736	61.8	4,200	.....
1927	279,333	7,727,760	27.7	9,202,621	32.9	425,239	1.5	17,355,620	62.1	4,500	.....
1928	300,010	7,303,680	24.3	9,908,799	33.0	362,776	1.2	17,575,255	58.6	4,800	.....
1929	307,450	6,635,760	21.6	9,813,767	31.9	380,353	1.2	16,829,880	54.7	4,800	.....
1930	337,480	5,910,512	17.5	10,255,274	30.4	440,607	1.3	16,606,393	49.2	4,800	.....
1931	393,390	6,714,969	17.1	11,892,996	30.2	492,035	1.2	19,050,000	48.4	4,800	.....
1932(c)	98,940	2,680,320	27.1	3,170,669	32.0	321,811	3.2	6,172,800	62.4	4,800	.....
1933(d)	.....	1,536,000	....	.....	....	264,950	...	1,800,950	....	4,800	.....
1934	226,470	6,098,271	26.9	6,430,427	28.4	360,551	1.6	12,889,249	56.9	6,800	.....
1935	447,090	10,232,996	22.9	11,632,104	26.0	387,871	0.9	22,252,971	49.8	7,812½	10,589

(a) Fiscal year ending with September. (b) Metric tons, 2,205 lb. (c) Operation were suspended for the calendar years 19 32–33. (d) Includes equivalent hp. in lighting transformers.

phase transformers step down the power from 13,200 volts to 480 volts. Present equipment also includes one 1,050-cu.ft. Worthington compressor, short-belt-driven by a G.E. 155-hp. synchronous motor, controlled by a manually operated reduced voltage starting compensator; two small circulating pumps; a 35-hp. sinking hoist; a 25-hp. pump; and the 40-hp. Westinghouse Gearmotor on the Mesa tramway.

Later on, this station will serve two more compressors with G.E. synchronous motors of 155 and 125 hp.; also a 225-hp. hoist motor and smaller motors for crusher, conveyors, and complementary machinery.

El Toro Substation—This station contains three 250-kva. single-phase Kuhlman transformers, which originally served the El Toro mill and mine, but now only have a connected load of about 200 kw., consisting of a G.E. 125-hp. synchronous motor driving a compressor that will soon be moved to La Mesa; a 50-hp. motor-generator set for the trolley locomotive; and two small hoists. Later a new hoist is to be installed at the San Jose shaft. It will be powered by a 150-hp. Westinghouse induction motor.

ELECTRIC WELDING is employed for a wide variety of purposes in the shops of the San Francisco Mines, serving in both maintenance and construction work. Gas welding is also used where current is not readily available.

Remedios Substation—Power is metered to this station through a Westinghouse type RA recording-demand watt-hour meter and checked by a similar instrument owned by the consumer. The power factor is determined by two single-phase watt-hour meters. Six 200-kva. Westinghouse single-phase transformers supply 480 volts for use at this point.

The 3,000 cu.ft. Chicago Pneumatic compressor is direct connected to a 500-hp. Allis-Chalmers synchronous motor with a pushbutton across-the-line starter. The 1,000 cu.ft. Worthington compressor is direct-connected to a 210-hp. G.E. synchronous motor with reduced voltage manually operated starter.

Power is delivered to the pump motors and other underground motors through a 500,000-cm 3-phase 600-volt rubber and steel armored cable. The motors are all of the ordinary induction type, manually controlled.

The 2,000-kw. steam plant, which has been shut down since 1931, could be put in operating condition if it became necessary. It could furnish enough power to keep the mines unwatered and for domestic use. Equipment includes a 2,200-kva., 440-volt A.E.G. turbo-generator and four 400-hp. Babcock & Wilcox oil-burning boilers.

IN THE ENGINEERING OFFICE main room at the hacienda. Besides the chief engineer, the staff includes eight other engineers and nine helpers, with a chauffeur and an office boy in addition. The office is equipped in the most modern way

Engineering Practice Well Organized

Staff of Ample Size—Mexican Concessions Require Special Surveys

H. G. Dudley
Chief Mine Engineer

THE San Francisco Mines engineering department has expanded a staff of two men in 1925 to an organization which now comprises a chief engineer, an assistant chief engineer, a safety engineer, (*ingeniero responsable*), three junior engineers, two draftsmen, a head sampler, three assistant samplers, six surveyor helpers, a chauffeur, and an office boy.

Previous to 1935, the engineering work was handled by two separate offices. One, which did all mine surveying, was located at the San Francisco mine. The other was at the general office. This same set-up was used for the first year after the resumption of production in 1934, the mine having been closed for the two previous years.

In 1934, the usual work required in reopening a mine was done, such as replacing of survey stations, studying the records and files, exploring the mine workings, and making new maps, along with the current routine operations.

In 1935, the engineering staff at the San Francisco mine was transferred to new headquarters at the general offices. The reopening of the Clarines mine and the expansion of holdings to include the El Toro mine made this change advantageous. It was also decided at this time to put the field work necessary for a large construction program under the mine surveying staff.

To facilitate the making of a composite surface map, and to correlate the mine workings with their respective claim boundaries, a triangulation system was established in 1928 to fulfill the need of permanent and accurate survey stations. This triangulation system originates from a base line 720 m. in length. The metric system is used for all surveying and mapping. The true length of the base line was determined from ten measurements, of which five were selected as having been measured under ideal conditions. Measurements which were affected by direct rays of the sun or by a vibrating chain were rejected. The remaining five selected were adjusted by the method of least squares and used as the true length. A 100-m. tape, standardized by the United States Bureau of Standards at 20 deg. C., and 24-lb. tension supporter, was used. All stations were constructed by setting 1½-in. pipe 3½-ft. long vertically in concrete. All pipes project from the concrete about 2 in. and are fitted with a cap which has a small drillhole in the center. Each station has its numbers marked in the concrete.

All horizontal angles were repeated twelve times, six with the telescope normal and the same number with the telescope inverted, with a 1-ft. Buff transit. As a check, both interior and exterior angles were measured in this manner. The primary system was established from triangles where the sum of the angles for each triangle were closed within five seconds. The triangles were adjusted and calculated using quadrilateral adjustments. Assuming the extreme sides of the triangulation system to be a closed traverse, an error of closure of $\frac{1}{895{,}000}$ was obtained. The secondary system was then set up by using one side of a primary triangle as a base. The system extends over an area of 3x7 km.

Starting from established triangulation stations, a traverse is carried to the required points by putting in wooden stakes with small nails for centering the transit and measuring. All horizontal angles are turned to the right. All distances are measured on the incline, and the vertical angles are read and recorded with the telescope normal and also inverted. Claim surveying is usually done by the *"ingeniero responsable."* Practically no surveying is required for the locating of a prospecting mineral concession, outside of locating the center point of a square 300 m. to the side and oriented in a due north-south course. There are no boundary points to be established, and the surveying is a simple matter.

Surveying of an exploitation concession is a little more complicated, and, in accordance with the mining law, definite steps must be followed. In the first place, the surveyor must of course identify the starting point on the ground, using for this purpose the data given in the application and any other information that may be supplied to him by the interested party. If the starting point is the corner monument of another lot, he must prove its location on the ground with the data contained in the corresponding title or docket. If there are any adjoining lots, he must establish the relation between the starting point of the petitioned ground and that of the adjoining lot.

The second step is to determine the true north. If in the vicinity there is not already a determined line course, the surveyor must proceed to obtain one either by an observation on Polaris or by a solar observation. Compass orientation is to be used only for preliminary work, and should not be used to establish a definite course.

Once the starting point is identified and the astronomic north is determined, the engineer proceeds to survey the lot without altering the terms of the respective application. He shall mark the location of the corner and intermediate monuments in such a way that a person looking from one can see the preceding and succeeding monuments. Only those monuments that are constructed in accordance with the data contained in the respective concession title are of legal value. If monuments are not constructed where the engineer marks

Table I—Linear Meters of Development Driven

1934	San Francisco Mine	Clarines Mine	El Toro Mine	Total
Drifting	1,942.3	86.9	Not operating	2,029.2
Crosscutting	732.9	1.7	.....	734.6
Rising	343.5	.....	.....	343.5
Winzing	16.1	.....	.....	16.1
Shaft sinking	38.9	.....	.....	38.9
Totals	3,073.7	88.6	.....	3,162.3.
1935				
Drifting	3,254.3	1,426.9	45.8	4,727.0
Crosscutting	412.7	256.9	....	669.6
Rising	503.9	474.7	....	978.6
Winzing	22.0	55.8	....	77.8
Shaft sinking	364.4	73.0	10.5	447.9
Totals	4,557.3	2,287.3	56.3	6,900.9

Note—Clarines mines was operating only two months in 1934. El Toro mine was not operating under San Francisco Mines of Mexico, Ltd., in 1934, and operated for only one month in 1935.

them, or if he does not mark the location of the monuments correctly, the monuments so constructed or uncorrectly designated are not valid in case of dispute or controversy. It must be remembered that the terms of the application must not be altered.

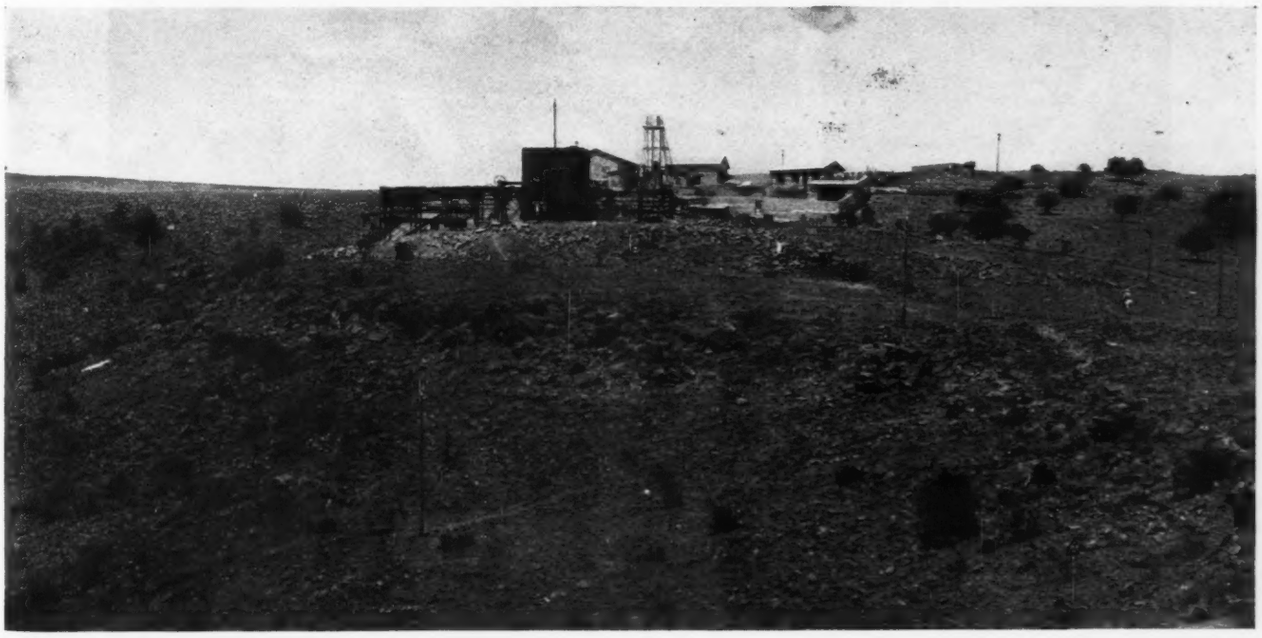
One other duty of the engineer is to obtain from any one of the vertices of the perimeter of the lot two "visuals." A "visual" is the astronomic course of the line of sight to a well-known and well-defined visible landmark. If only one visual is obtained from any one of the vertices, the engineer must report the course and the horizontal distance to the reference point. Once the monuments are constructed where the engineer staked them, he must certify that such is the case. The engineer must make the annual report of assessment work done on the mining lot.

Underground surveys are tied to the surface principally by plumbing the shafts. The two-wire method is used, which consists of the "jiggling in" of a transit on the line of the wires at the surface, where the bearing and coordinates are known, and the "jiggling in" of another transit underground, where the bearing and coordinates are transferred to survey stations placed in the roof of the drift or crosscut. Two independent surveys are made, using different distances from the wires before removing them from the shaft. This naturally gives two sets of horizontal angles from which the bearing of the wires can be calculated for a check in the field. Likewise, by assuming a bearing of the wires at the underground set-up, the transferring of the bearing to the survey plugs can be calculated from the two sets of horizontal angles for a check. It has been found that the placing of the wires in the shaft requires considerable time compared to the transit work, and this precaution has been found to be warranted. When plumbing new levels the bearing and coordinates of the wires are determined by checking back from stations established on the two lower levels of the previous shaft plumbing. All horizontal angles are turned four times and recorded.

Drift surveys are carried from the established points near the shafts to the various faces. A 50-m. tape is used, although stations are placed at distances not over 35 m., as this is considered a fair limit. All angles are turned four times, horizontal distances are measured, and the height of instrument and height of point are measured in order to carry elevations. The distance from the survey station to the track is also recorded. This is used to carry a grade sheet on the track, as all tracks are carried on a ½ to 1 per cent grade with the load. Rights and lefts are taken from the tape, as it is held on the line between two consecutive stations, to the walls of the drifts. These data are used to plot the drift. Check surveys are made when thought advisable and the levels checked by independent leveling.

Stopes, rises, and winzes are surveyed with a Keuffel and Esser hanging compass and clinometer. Numbered points are carried in the manways of the stopes which originate from the primary drift survey. They are transferred as the stopes are carried up or down, as the case may be, and used as a tie for the stope survey. Temporary points are used in running a survey through a stope.

Traverse tables or a slide rule are used in calculating distances in stopes. All bearings are corrected for declination. A protractor is used in plotting the traverse on the plan of the stope map. The points are projected to the longitudinal vertical section and plotted according to elevation. The area between the new line of the back of the stope and the previous line is then measured by planimeter. An average width of the stope is then calculated. The volume broken is found from the



ON THE MESA, here seen (the plant is that of La Mesa Shaft of El Toro Unit), a 720-m. base line was run by the engineering department in 1928, when it established a triangulation system to meet the need for permanent and accurate survey stations. The line's true length was determined from ten measurements

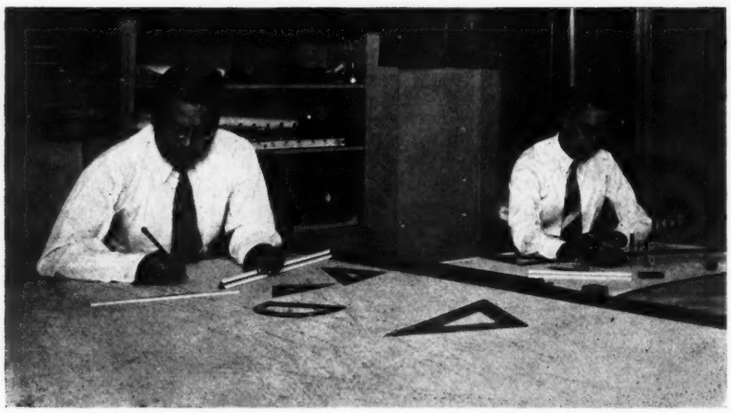
product of the area and width. If a dip factor has been applied in plotting, it must be used also in determining the true volume broken. Stopes are measured at least once a month. A record is kept of the ore broken and ore hoisted from each stope. The types of stopes measured are cut-and-fill, bench or underhand, and shrinkage or overhand. The material broken monthly at present in the San Francisco mine amounts to approximately 40,000 metric tons and in the Clarines mine to about 10,000 metric tons.

Sampling is under the engineering department and in charge of a head sampler, who at present is carrying on the work with three samplers. All drifts are sampled as they are driven and the stopes, also, when the mine superintendent thinks it necessary. A two-meter interval is used for drifts. In stopes the interval varies from three to five meters. A 3-in. channel is cut by hand. Samples are accurately located in reference to survey stations. Five hundred samples are cut monthly.

Geology is mapped in all drifts and crosscuts as they are driven. Observations are made in stopes, rises, and winzes occasionally. All veins, faults, slips, and dikes are plotted in reference to survey stations. The strike and dip are noted and such side notes as are thought necessary are also recorded. A combination pocket protractor and scale is used for plotting. Different geological features are denoted by the use of colored pencils. A 7x10-in. loose-leaf sheet of coordinate paper (Eugene Dietzgen Company) is used for making sketches.

A general composite plan of each mine is carried on a 1:500 scale. Thes maps are on mounted drawing paper and are brought up to date monthly. A longitudinal, vertical projection of each vein is also carried on the same scale and same kind of paper. Assay plans and geology plans are carried by levels on tracing cloth, using the 1:500 scale. Cross-sections showing the different veins are carried on tracing cloth at 100-m. intervals, using the same scale. These geological maps are too unwieldy. New ones are being made to scale 1:1,000. A general surface map is carried on tracing cloth at scales of 1:4,000 and 1:8,000. These show vein outcrops, claims, shaft locations, triangulation stations, topography, tramways, roads, and various features of importance. Insurance maps are carried on 1:1,000 scale showing the buildings, water lines, and the like.

All maps are made with the observer looking west in the case of plans and



THE MAP ROOM of the engineering office with the two draftsmen

THE ENGINEERING DEPARTMENT'S TASKS have included, among other things, the surveying of the lines required for bringing the San Francisco section of the rope tramway 3,000 ft. through La Tinta adit to old stopes used as underground bins at the point here shown

longitudinal sections and to the south in the case of cross-sections. All mapping is correlated by a coordinate system. Coordinates 20,000 latitude and 10,000 departure run through the center of the North Shaft at San Francisco mine. This is the basis for the numbering system. The location number of any chute, working place, or other feature in the mine is its distance in latitude from the North Shaft measured to the nearest whole meter. A drift or crosscut bears the number which locates its starting point, the name of the vein which it is on or which is its objective, and letters giving its general direction. A tin plate bearing the corresponding number is placed on each chute. This numbering system is very helpful in pulling stopes and in determining your location at all times. The veins have a general north-south strike which makes this system very adaptable.

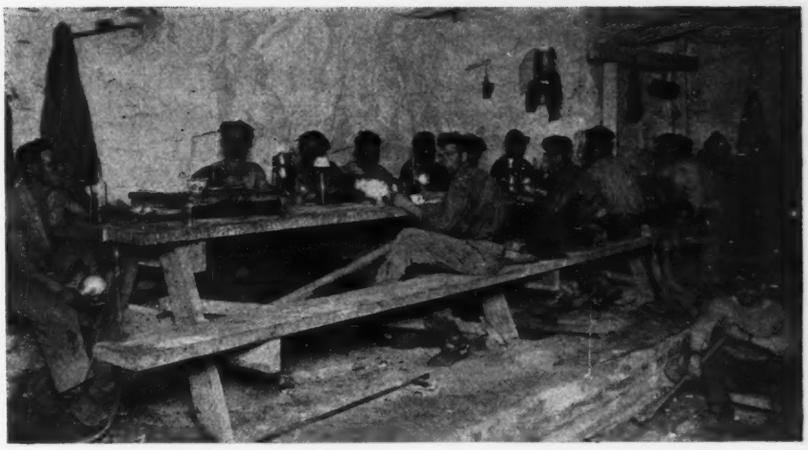
The lettering for thirty monthly summaries is done by a draftsman under the engineering department. These summaries are kept up to date by the various departments on white prints, from which the data are transferred to tracings. These summaries show complete costs pertaining to the mining, milling, and smelting. The printing includes two types of prints—that is, the blueprint and the white print or Ozalid. A Pease Peerless blueprint machine is in use.

Field work for a construction program that included a new tramway, hoists, compressors, crushers, conveyors, ore bins, and buildings for the Clarines and El Toro mines, along with new shops and extensions to the mill, is being handled by the engineering staff. The construction department, a separate office, is in charge of all designing and drafting for this work.

The filing system used by the company is simple. All notes are kept on loose-leaf sheets. In size these sheets are 4½ in. wide and 7 in. long when doubled. A separate file is made for each mine and plant.

The mine files are divided as to veins, with a division for each level. Separate files are kept for transit, stope, rise, winze, and level notes. The same set-up is used for the notes that show the monthly advance in drifts, crosscuts, rises, and winzes. Files are carried for triangulation, for the shafts, and for claim surveys.

A monthly report is made for the different mines. Separate data are kept for the sulphide and oxide sections, for each mine. The following are included: ore blocked versus ore hoisted; ore broken versus ore hoisted; ore broken and hoisted by veins, levels, and mining methods; mine tonnages trammed and hoisted; broken ore reserves in stopes and dumps; development by working places; development by class of work; development by veins; stope preparation; and tables showing the expected grade of ore.



UNDERGROUND EATING PLACES, such as this, each equipped with an electric hot plate on which the men heat their tortillas, coffee, and other food, are provided by the company and make it possible for the miners to have their meals hot

Labor Relations
Covered by Collective Contract

Numerous Detail Records of All Mexican Workmen Necessary

W. E. Wiegand

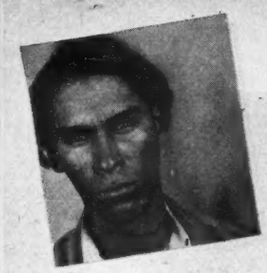
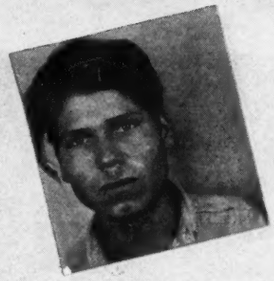
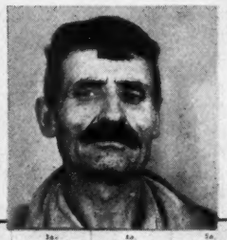
Personnel Department

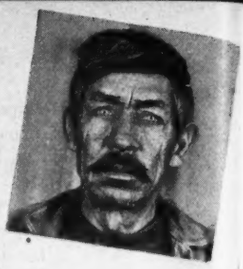
THE employment or personnel department has a wide range of activity, having charge of employment of labor, complaints and reconciliations, and payment of indemnities for injuries and deaths. In general, anything pertaining to labor comes within the scope of its endeavors.

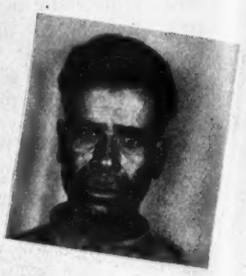
Before describing its methods of operation, the reader must be informed that the great majority (at least 90 per cent) of the workmen belong to the union, this particular union of miners, smeltermen, and workers of similar nature being the strongest organization of its type in Mexico; and that a collective contract is in force with the union, which controls all labor matters. This contract must comply with the Laws of Work of the Republic, and in part elaborates on the laws. In brief, the collective contract provides for and makes compulsory the following:

1. Collective bargaining
2. Closed shop
3. Six days' work only each week and payment for seven, provided six consecutive days have been worked in each working week
4. Three legal holidays each year with payment for these days
5. Annual vacations with pay from six to fourteen days, depending on length of service
6. Full pay for all time off as a result of injuries sustained while at work
7. Half pay for time off for sickness for a period of 60 days
8. Strict seniority in promotion
9. A fixed wage scale
10. Indemnity for professional sickness
11. Collection of union dues by the company
12. Permanence of employment, practically
13. Provision and mainteance by company of schools for the children of its workmen, and has ten to fifteen teachers on its payrolls
14. Eight hours' work on day shift, 7½ on second, 7 on third

The Laws of Work hold that any industry whose workmen belong to a union must enter into a collective contract. Any employees with a concern at the time the contract is made may become members of the union, but are not compelled to do so. But all new employees must belong to the union and must be applied for through the union closed shop. Therefore, in employment of required labor, the employment office sends in a request to the union for the type and class of the workmen needed. The union selects the personnel and sends them to the employment office with their proper credentials. Here the individual candidate is photographed, front and profile, and a form filled out with complete description, family history, children and dependents; also past activities as regards previous work and jobs. He is then sent to the hospital for physical examination, which is very strict owing to the severe requirements of the laws. If he is scheduled for





No. TARJETA	1a. SEMANA		2a. SEMANA		3a. SEMANA		4a. SEMANA		5a. SEMANA		TOTAL		NUM.	DEPARTAMENTO
1935	DIAS	IMPORTE	DIAS	IMPORTE	DIAS	IMPORTE	DIAS	IMPORTE	DIAS	IMPORTE	DIAS	IMPORTE	H. A. V.	
ENERO	-	-- --	-	-- --	-	-- --	-	-- --	-	-- --	-	-- --	---	----------
FEBRERO	6	32.00	4	21.40	6	32.10	5	26.75	-	-- --	21	112.35	227	Op. Molinos.-
MARZO	5	26.75	4	21.40	7	42.80	5	26.41	3	10.65	24	127.01	"	" "
ABRIL	6	32.10	7	37.45	6	32.10	6	32.10	-	-- --	25	133.75	"	" "
MAYO	6	33.40	6	36.00	6	36.00	6	36.00	6	36.00	30	177.40	"	" "
JUNIO	6	36.00	6	36.00	6	36.00	4	24.00	-	-- --	22	132.00	318	" "
JULIO	3	18.00	5	30.00	6	36.00	6	36.00	-	-- --	20	120.00	"	" "
AGOSTO	6	36.00	6	36.00	6	36.00	6	36.00	6	36.00	30	180.00	"	" "
SEPTIEMBRE	6	36.00	6	36.00	7	42.00	6	36.00	-	-- --	25	150.00	"	" "
OCTUBRE	5	30.00	6	36.00	6	36.00	6	36.00	-	-- --	23	138.00	"	" "
NOVIEMBRE	6	36.00	6	36.00	6	36.00	6	36.00	6	36.00	30	180.00	"	" "
DICIEMBRE	6	30.00	6	36.00	6	36.00	7	42.00	-	-- --	25	150.00	"	" "
TOTAL	61	362.35	62	362.25	68	401.00	63	366.26	21	116.65	275	1610.51		

LE CORRESPONDEN 10 DIAS DE VACACIONES CON FECHA Diciembre 15 de 1935

CLASIFICACION MEDICA 1

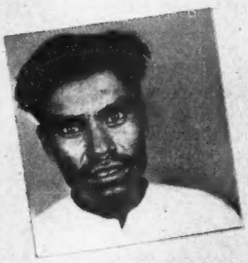
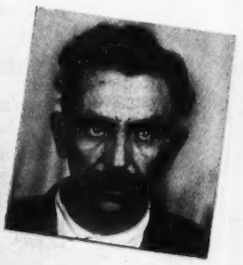
TIEMPO EN EL EMPLEO DE LA COMPAÑIA Registrado en noviembre 10 de 1927.-

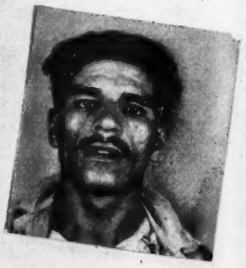
OTROS DETALLES Dias trabajados - 1927 - 36, 1928 - 345, 1929.- 336, 1930 - 362, 1931 - 314, 1934 - 323,

NACIO Villa Matamoros, Chih.-

NOMBRE BETANA LUCIAS 921

A RECORD CARD, such as this, is kept by San Francisco Mines of Mexico for each of its Mexican employees. Each man is photographed and given a number to correspond with his card. Some of the men so photographed are shown on this page. Below is one of the three rooms occupied by the Personnel Department.



underground work, the examination includes an X-ray picture for "silicosis," the one professional disease common to miners. If for surface employment, the physical examination is just as strict as for an underground job, but no X-ray is required. The results of examinations are graded to show whether the candidate is physically capable and a good risk for the job or not. These data are put on the forms previously mentioned. In either case, the data are filed under the candidate's name for future reference. It might be stated here that the average number of men who can pass a physical examination for underground work is about one in twenty. This average is higher as regards the men who apply for surface work.

The man who passes the examination is then given a card with his picture and number, his work and wage, and is directed to present it to the department which requested the service of a man in his category and he is put to work for a trial period of thirty days. At the end of this trial period, if his services are not satisfactory he can be dismissed. But if they are satisfactory, he then becomes a permanent employee of the company and his dismissal becomes difficult owing to the restrictions that are placed upon dismissals by law.

During the whole time the man stays in the employment of the company, a complete record is kept of his attendance, sickness, injuries, money paid for his services or indemnities, changes in category of work, and similar related information. Such data may seem excessive, but they are absolutely essential in complying with other parts of the collective contract, as, for instance, advancement to better jobs. When a position is vacated in any department, all employees of that department may apply for it. The governing factors to get the job are length of service and competence to do the work. Records only can produce this information. Another matter is that of vacations. Workmen are given vacations, with pay of from six to fourteen days per year, depending on length of service. For certain unjustifiable absences from work, this time lost can be deducted from the vacations. Thus, other reasons for such complete records.

Dismissal of a permanent workman is difficult. A man can be dismissed if he is absent from work without justifiable cause for more than three days in any thirty, for being drunk on the job, carrying arms, theft, and similar prohibitions. If a man resigns from or is expelled from the union, his dismissal from the company can be requested.

Complaints and Reconciliation—All differences between a workman and the company are handled by this department. Generally the workman is represented by some secretary of the union. All cases are given careful attention, and a satisfactory settlement on the local field is aimed at. Most disputes are conciliated without resorting to intervention of Federal authorities. When not, a demand is made on the company covering the particular case and it is taken to the nearest office of a Federal labor inspector. There both sides of the case are presented before a board consisting of a president, a Federal labor inspector, and a representative of the workers and one of capital. All evidence is taken and a decision is handed down. If not satisfactory to either or both of the parties, it is then sent to a similar board in the Department of Labor at Mexico City with all data from the local board. Here, owing to the amount of business being handled from all over the country, months might pass before a decision is rendered. This generally is final, but there have been cases where decisions were unacceptable, and they have reached the Supreme Court. Naturally, that Court's decision is final and is complied with.

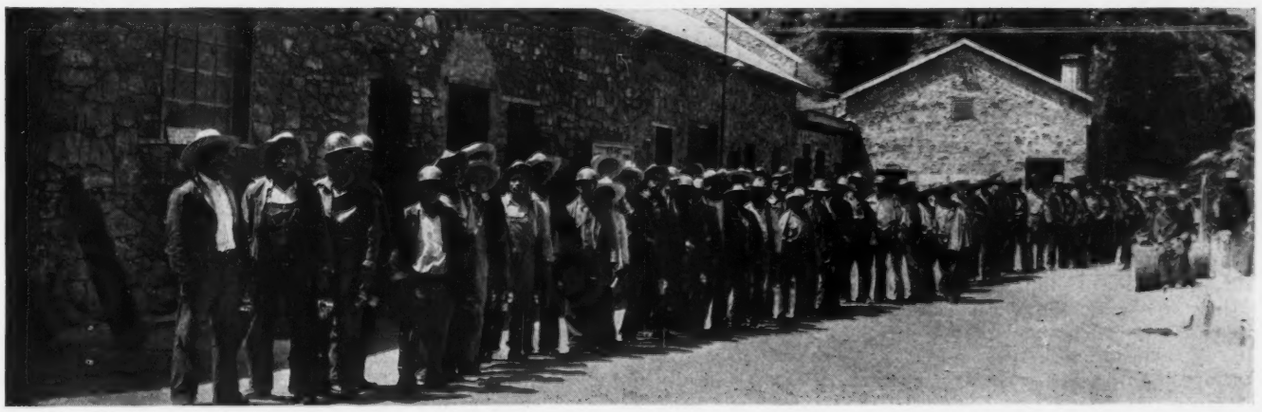
Accidents and Professional Sickness—The company maintains a hospital, up to date in every respect, which is described in the article on safety. Workmen suffering any accident received on the job are given full pay and medical attention until cured. Those suffering a professional sickness are on full pay and receive medical attention until cured or until the percentage of incapacity caused by the illness is determined. This department handles the payment of these indemnities. Also, payment for disabilities and deaths are functions of this office. Care is essential that the beneficiaries are according to law entitled to indemnities in case of death, and are never paid without the intervention of the Federal labor inspector.

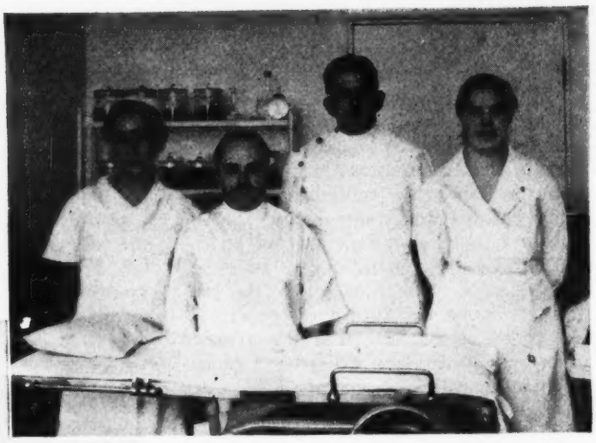
Education—The company was by law required to build a school for the education of its workmen's children or dependents of school age. This school is maintained, the teachers are paid, and all books, materials and athletic supplies are bought by the company. That the pupils are either children of or dependent on the workmen is another care of the personnel department, for if a careful register is not regularly taken, the school becomes not one for the workmen's benefit but for everybody else as well. The school is controlled by the laws of the Federal Board of Education; in direct charge is a director. Teachers are supplied in the ratio of one to each fifty pupils or multiples thereof. Their salaries are set by the board, being controlled by the type of school. At present there are about 700 pupils in the school with lawful rights.

Wages—A scale of wages for all classes of work is in effect. The employment department has each laborer listed in his proper category, with corresponding wage and records of any changes. These serve to determine conflict or claim that the workman is improperly paid for the work he does, and as a basis for indemnities.

The company employs between 2,000 and 2,500 men, and to maintain the records as complete in information as is required, the department office force consists of a head and four clerks.

THE CARBIDE LINE at the San Francisco Unit. Before going underground the men of each shift receive 225 grams of carbide each for their lamps. Bosses and "powder monkeys" get somewhat more, according to their needs





THE NEW HOSPITAL, which is fully equipped with modern medical and surgical devices. A staff of two experienced doctors and four graduate nurses tend about 150 persons daily who come for consultation. At the right, the hospital staff

Employees Well Safeguarded

Education, Aided by Posters and Bulletins, Secures Effective Observation of Safety Rules—"Seguridad Primero"

R. Rangel

Ingeniero de Minas Responsable

MOST SAFETY MEN have depended on education and safeguards as the best means of preventing accidents, and these two factors will, without doubt, always continue to be indispensable. Another factor which modern companies have deemed necessary for their safety organization, to obtain maximum success in accident prevention, is to use their engineers to aid in solving the accident-prevention problem.

Those responsible for the formulation of the present Mexican mining laws considered this last factor of such importance that one of the clauses of the law requires that every mining company have in its safety organization a safety engineer who must be a graduate mining engineer of an accredited college. This engineer in mining companies is called **"Ingeniero Responsable."** With most companies it is customary to have the "Responsable" directly in charge of the safety oranization. At the property of the San Francisco Mines of Mexico, the organization is in the main independent of the operating department and is regarded as satisfactory. An outline of the organization is given herewith.

Mine Supervision and Inspection—Mine bosses are required to visit all the working places of their divisions daily. The foreign bosses generally know Spanish well enough to be understood when giving orders, and the Mexican bosses are all practical safety miners.

The mine superintendent and the mine foremen make an inspection of the mine daily, and, in addition, there is a detailed inspection of the mines and mill by the safety committee, composed of the chief of the safety department, his assistant, and two workmen. It is specifically urged in the company safety rule book that every man report any danger at his place of work either to the committee or to his immediate boss.

General Safety Education—The most important and reliable method of preventing accidents is through general safety education. The safety rule book of the San Francisco Mines consists of 70 pages, and in it are included all the necessary safety rules for the mines, the mill, and the shops, and general rules of hygiene and sanitation.

All the rules were formulated by the permanent safety committee, composed of representatives of the company and of the workmen. The committee itself drew up the wording of each rule after having listened to the suggestions of a workman appointed from each department who had previously, from a safety point of view, developed a list of accident hazards to which the workers on that department were subjected. The rules are specific and clearly worded, to prevent misunderstanding. Books on safety are distributed to all new workers at the time of employment by a member of the safety committee who is responsible for properly instructing the workmen respecting the observance of safety rules.

Once a man has studied and understood the rules of safety there is no assurance that he will remember them indefinitely. Therefore the safety committee promotes plans to recall these rules to the men, so they will not be forgotten. Publications and posters are read and explained at safety meetings for the benefit of those unable to read. Bulletin boards are placed at conspicuous places. Posters are changed twice each week, are illustrated, and are printed in Spanish. Repeatedly interest is aroused by displaying objects which have been a contributing factor in causing or preventing an accident. Broken goggles and damaged hard-boiled hats, together with the story of the accident or the would-have-been accident, make good displays. Among the items exhibited on bulletin boards are the accident statistics, complete

record of which is kept by the department.

Acknowledgment is general that the use of warning and danger signs plays an important rôle in the reduction of accidents. The number of signs is limited only to those considered absolutely necessary, to point out specific hazards which cannot otherwise be safeguarded. The most widely used signs are those concerning explosives. They are posted wherever commercial explosives are stored, both on surface and underground. Next in number are the "No Smoking" signs, and next to the electrical department signs are the grinding-wheel signs, which indicate plainly that goggles must be used when operating the machines.

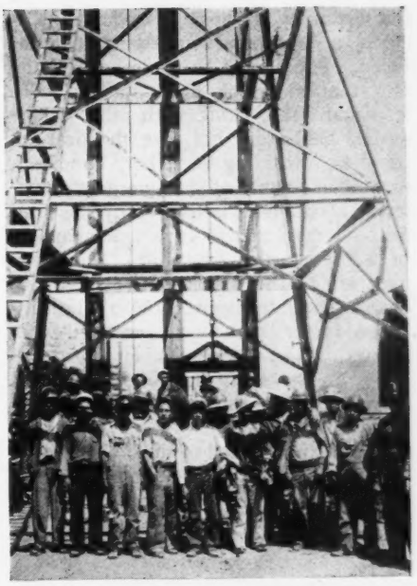
At the mines an effort is made to hold a meeting once every two weeks at each level. These meetings are held at the level stations at the lunch hour. At every shaft station the company maintains a dining table, a running-water washstand, and an electric hot-plate. Taking advantage of this lunch hour, the committee reduces its talk to the explanation of rules of which the records show there has been more disregard. The general meeting held once a month at a public hall is of longer duration, and besides the safety talks there is an entertainment feature to induce the attendance of the men.

At the mine, mill, and the shops, guards are placed to protect all gears and belting that are likely to come in contact with the clothing of workmen. All shaft collars are fenced off by railings, and at the different levels self-shutting doors are always kept in good condition.

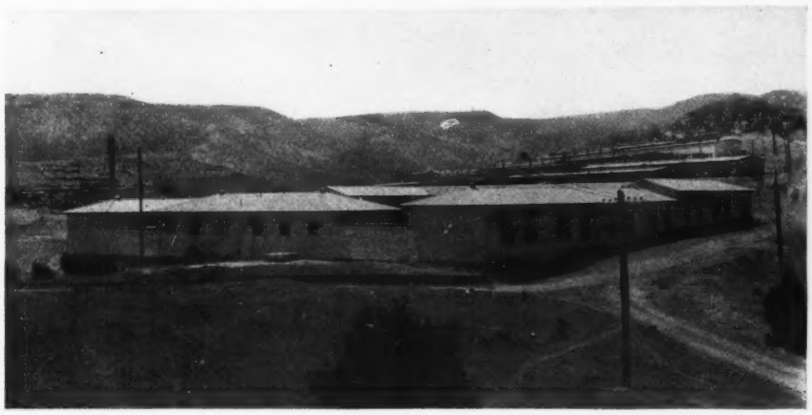
Other than the usual machine guards, are protective clothing and personal objects such as goggles, hard-boiled hats, safety shoes, and dust respirators, powder bags for transportation of explosives, rubber coats for men working in wet places, asbestos gloves for foundry men, safety belts, and similar protective apparatus. All these are supplied to the men and are intended for their protection.

Caring for Injured Workmen—Another phase of safety education is that covered, indirectly, by training for first aid. This training not only provides for emergency treatment of accident injuries but contributes in a large measure to their prevention. In the handling of minor injuries, the person injured may obtain first-aid treatment at the first-aid room underground, or he may wait until he is able to get to the first-aid room on the surface, where a competent man attends him and makes out his accident report. From there he is sent to the hospital, where he is cared for by the doctor or nurse. An injured person stays under the care of the doctor until he is dismissed from the hospital by the latter. Injured men get full pay while at the hospital. Men with injuries that are hard to heal, but who can do some kind of physical work, are put at simple odd jobs on the surface, where fresh air and sunlight promote their recovery.

When a serious accident occurs, the first-aid man at the surface is at once informed, and he in turn first telephones



SAFETY RULES prescribe that every person who goes underground shall wear a hard hat. Here are the men at the Reforma mine, about to be lowered thus equipped



THIS SCHOOL HOUSE, costing $22,000 U. S. currency, has recently been built and furnished by the company for the instruction of the children of the Mexican workmen

MEXICAN SCHOOL CHILDREN. The photograph of this group was taken on "Clean-Up Day," which is the last day of April. The following day, May 1, is usually celebrated by the children and their parents

the doctor at the hospital and then proceeds underground to attend the injured. Point must be made here of the fact that at every level station there is a man who, along with other minor duties, has under his care the first-aid supplies, including stretcher, bandages, tourniquets, and other emergency material. This man is trained by the head first-aid man and is considered capable of administering first aid. Stretchers used are of the wire-basket type which enable safe transportation of the injured under the most awkward conditions. The victim is either transferred to the shaft on an empty car or carried on the shoulders by men. At the level station, the cage is waiting to transport the injured to the collar, where an automobile properly fitted to convey persons on a stretcher is in readiness.

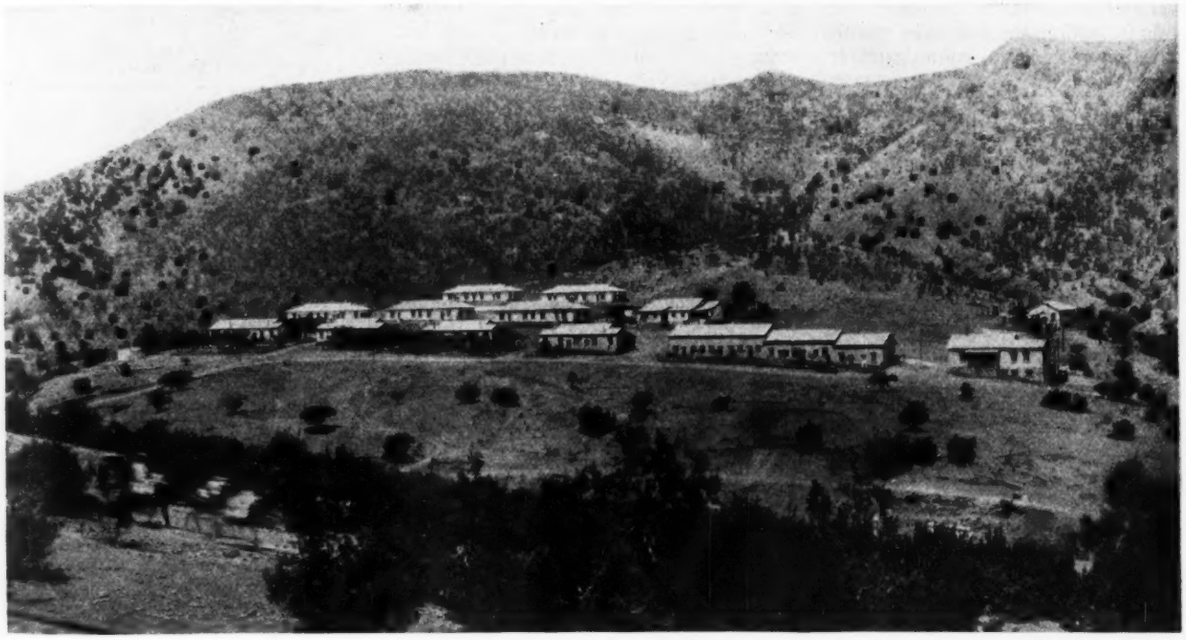
If a fatal accident occurs, the victim is not to be moved until the local authorities arrive to investigate the case. Notice of a fatal accident must be given as soon as possible to the local authorities, which in our organization include the local judge, the District Attorney and their secretaries. The District Federal Mine Inspector and the District Labor Inspector are notified by wire within 24 hours. The Mexico City offices of the Mining and the Labor departments are also notified by wire.

At the regular investigation of a fatal accident the local authorities by law demand the presence of the individual who directly supervises the mine, the level boss, the "Ingeniero Responsable," the mine doctor, and the witnesses. Having finished their questioning, the authorities give permission to transfer the corpse to the hospital or to the home of the victim. The doctor must render a death certificate stating the physical causes of death. One copy of the death certificate is given to the employment office and another to the "Responsable," who must include it in his report for the Federal Mine Inspector.

The regular routine of the hospital crew covers a much wider scope than just looking after mine and plant accident cases, and an outline is herewith given of the field covered by the medical department. The personnel of the department comprises a head doctor and two assistants, (all full-time employees), three graduate Mexican nurses and one American nurse; two office men, and two orderlies. The hospital proper comprises three wards: one large one with eight beds and two smaller private wards, one with two beds and the other with one. Within the hospital proper are also found a complete pharmacy, a large hall for treating minor injuries, and the usual consulting office for the doctor. The kitchen and quarters for the nurses are also included. The building and the baths are steam heated. Another building separate from the hospital proper is provided for care of professional diseases, silicosis being the principal disease of this class. Adjoining the hospital there is the head doctor's private residence.

Before each man is employed he must undergo a thorough examination, and a complete record is kept in the files of the company. The purpose of these examinations is twofold. First, an accurate record at the time of hiring may prevent later trouble with questionable injury cases, and, second, examinations are the means of ascertaining the physical qualifications of prospective employees and fitting them to jobs where they will not experience discomfort or injury, or cause injury to themselves, to others, or to the property.

Hospital equipment consists of an up-to-date operating table, an electric knife, complete X-ray equipment, a fluoroscope, an autoscope sterilizer for water, cloth, and instruments, and a complete set of instruments for operating. The hospital is also equipped with a metabolic machine for testing goiter, as a fairly high percentage of Mexicans are affected by lack of iodine. The hospital is up to date and fills all requirements of the law. Additional equipment will be installed for laboratory testing and research.



THE SAN LUIS COLONY, where Mexican staff members have their homes. On the right is their club house and in the valley is a concrete tennis court

Federal Inspection—The mine inspector's time is taken up mostly in examining conditions at the mines and plants. He makes regular, ordinary visits to the mines besides the special visits already mentioned when a fatal or unusually serious accident occurs. His reports, or *actas*, are made in the presence of the company's general mine superintendent and are signed by the inspector, by the general mine superintendent, and by the "Ingeniero Responsable." When a fatal accident accurs, the inspector is given a copy of the doctor's death certificate, together with a copy of the statements made by the witnesses to the accident. Also, he is furnished with any sketch or plan that will help to make clear the causes.

NEWS
OF THE INDUSTRY

New Gold Deposits of the Rand Extend Far Beyond the Old Reefs

Thousands of Feet of Drilling Reveal Gold in Commercial Quantities

Johannesburg Correspondent

BEFORE SOUTH AFRICA went off gold, 32 gold mines produced $200,000,000 worth of gold annually on the 60 miles' stretch of the Witwatersrand. Now, by reason of amazing recent discoveries in the West, the Witwatersrand is likely to become a gold field nearly 200 miles in extent, with a potential output of $500,000,000 a year and an almost indefinite life. Overwhelming evidence is accumulating that the Main Reef Series is persisting for many miles beyond the previously accepted western limit of the Witwatersrand gold fields. About 250,000 ft. of boring has already been done in the new area, which lies beyond Randfontein in a southwesterly direction towards the Potchefstroom Klerksdorp area, and nearly 90 per cent of the borehole results to date have revealed payable ore.

A geological survey of the field, just published by the Union of South Africa Department of Mines, states: "The problem of the westerly extensions of the Witwatersrand gold fields beyond the farthest big gold producer on the West Rand (Randfonstein) is one of great importance to the future economic history of South Africa. With the view to determining the trend and significance of the concealed mass of Witwatersrand rocks between West Rand and Klerksdorp, extensive geological and geophysical investigations have been carried out in recent years and are still being actively prosecuted by various gold-mining companies.

"'Everything that has happened in this area has gone to confirm the correctness of the most optimistic forecasts,' said a very prominent Johannesburg mining engineer in an interview with your correspondent. 'At this early stage we must maintain a waiting attitude in the matter of actual reef nomenclature. We cannot yet with absolute certainty call the reef bodies Main Reef, but we can state that—whatever their name—many of them are workable'."

Mining engineers are finding that the New Rand has not so steep a dip as was at first believed, and although earlier strikes indicated that the Reef ran at an incline of about 30 deg. it is now assumed that near Potchefstroom the formation flattens somewhat and may not be steeper than 20 deg. This would indicate that very large lease areas are needed to establish individual mines, as is already the case on the Far East Rand. It is also found that the giant sheet of Ventersdorp lava, known as amygdaloidal diabase, is not as thick everywhere as was originally assumed. Its thickness varies from 500 to 2,000 ft. Water difficulties are less serious than was expected. Venterspost, where underground streams in the dolomite occur, is providing unique experience in the matter of cementation.

The Far West field must at present be regarded as consisting of three more or less isolated, but probably connected, areas of exploitation. The region around Venterspost and Libanon has already reached that stage of development where systematic mining can be inaugurated. Linked to it by a fairly continuous chain of boreholes is the block of farms around Blyvooruitzicht, where several payable strikes have been made. This chain of holes continues nearly to Potchefstroom. The 40-mile stretch between Potchefstroom and Klerksdorp in the southwest has not yet been closely examined. Many good strikes have, however, been made in the vicinity of Klerksdorp, where several small mines already have been producing for a long time. Geological disturbances and dikes beyond Randfontein have been few, so far, and only minor displacements in the general run of the reef have been noticed.

John A. Agnew, chairman of the Consolidated Goldfields of South Africa, which controls West Wits, the most important mining company in the Far West, at the last annual meeting went so far as to say: "To state that we have proved to date that the Main Reef Series underlies the area (West Wits holdings) for a length of 23 miles, and to express confidence in its continuance for another 14 miles, may be regarded as insufficient without some reference to the value we expect to obtain in development work. It is obvious that it is impossible at this stage to indicate any definite figure; it may, however, be regarded as certain that a highly profitable average value can be looked for." Since this address a series of additional borehole results has helped to bear out Mr. Agnew's contentions.

At least half a dozen shaft sites have already been selected tentatively on the new Rand, and before the end of the year those interested expect to see as many headgears going up. By the end of 1937 it is anticipated that half a dozen more mines will be under development between Klerksdorp and Randfontein. Already the new field employs about 500 whites and 3,000 natives, and this number will soon be multiplied many times.

Considerable attention has been paid lately to the production of South African base metals. Production has increased in the past two years and export is gradually being improved. Whereas the value of all sales of base metals in 1934 was $5,300,000, this figure had increased to $6,350,000 in 1935 and will be considerably higher this year.

An Interdepartmental Committee has been formed by the South African Government to develop the local base-metal industry and to investigate problems of production and marketing. A technical officer of the department is now stationed in the South Africa House, in London, where he will be in touch with European and American markets.

LOCATION OF PROPOSED TUNNEL to be made on the property of Wasatch Gold Mines, Inc., which is making preparations for active development of its mine, located in the Alta Cottonwood district 25 miles southwest of Salt Lake City, Utah

Utah

Greater Activity in the Cottonwood District

FRISCO SILVER finds downward extension of orebody

✦ Mining development in the Alta Cottonwood district, 25 miles southwest of Salt Lake City, has been augmented by the beginning of work by a new company, Wasatch Gold Mines, Inc. This company has secured the 18 claims of the old Cottonwood Silver King Mining & Milling Company and 26 claims in addition. A road is being built up Mineral Fork Canyon from Big Cottonwood Canyon, and as soon as the wagon road is completed the prospect will be equipped with power drills, compressor, and a 60-hp. caterpillar. The company reports that in the upper tunnel it has opened 4 ft. of ore. At 150 ft. below, 18 in. to 4 ft. of ore have been found, and in the main tunnel, which is 430 ft. deep on the vein, 10 in. to 7 ft. have been opened. Values are said to range from $10 to $20 in gold.

✦ At the Cardiff, a drift is being driven on the 1,550 level. Ore is being removed on the 1,400 and 702 levels, and development started on the 600 level. Shipments consisting of a good grade of silver-lead ore are being made steadily.

✦ At the Frisco Silver Lead mine, near Millard, a continuation of the rich orebody opened up on the 225 level has just been struck on the 300. Width of the ore is variously reported at 4 to 5 ft., and assays reported on 2 ft. of sulphide ore are 14 per cent lead and 14 per cent zinc; oxidized ore, 18 in., 33 oz. of silver and 40 per cent lead. Several carloads of high-grade ore have been shipped from the 225 level. In the adjoining King David mine, controlled by the same interests that own the Horn Silver, limestone impregnated with galena has been struck on the 700 level in the west drift.

✦ The Flagstaff mine of the Columbus Consolidated Mining Company is shipping a carload of gold-silver ore weekly. In the Rexall mine, the company is rehabilitating the main tunnel and developing work in the No. 9 fissure. A geologic study of the company's extensive holdings is being completed with a view to starting intensive development from the Wasatch Drain & Transportation Company.

✦ The Great Buffalo Company, northeast of the old Century mine, in Park Valley, recently completed a road to the mine for the trucking of ore from the mine dump. Development consists of driving a tunnel and following 8 to 10 in. of commercial ore. The company estimates that it can ship two carloads a month averaging $13.30 in gold. Other metals in the ore are said to bring up the value of the total metal content to $20 a ton.

✦ Sinking of a winze in the Prince of Wales tunnel in the Utah Ophir Mines property at Ophir has resulted in the opening of a body of ore reported to contain commercial quantities of silver and lead.

✦ A number of claims have been filed in Rush Valley, Tooele County. Excitement has been caused by the report that gold ore had been struck near the Clover Creek spring. The formation is said to be similar to that in the Mercur district, lying to the north.

Colorado

More Mines Rehabilitated

MOLLIE KATHLEEN shaft, in Cripple Creek, to be deepened

✦ Mrs. Verner Z. Reed, of Denver, who opened up the Hill Top Mine of the Tenderfoot Consolidated Mining Company in October, 1933, to help provide work for the unemployed miners of Cripple Creek, has now leased the Mollie Kathleen, the Queen Bess, and the Sangre de Cristo group, on Tenderfoot Hill. Plans are under way to extend the shaft of the Mollie Kathleen 300 ft. to the 1,000-ft. level. An air hoist will be installed on the 700-ft. level to facilitate shaft sinking. A compressor will be installed on the surface.

✦ A. F. Carper, of the Squaw Gulch Mining Company, Cripple Creek, has erected a new headframe on the Dolly Varden shaft and will soon finish retimbering the mine. Following the installation of a hoist and a compressor, operations will start.

✦ Jack Sharp has been appointed superintendent of the Blue Moxie Company, operating the Blue Bird property. The first work planned is the sinking of the shaft to the 2,400-ft. level to connect at that point with the Roosevelt drainage tunnel.

✦ Tom Kavanaugh is using a straight cyanide treatment on strictly oxidized ores, and is said to obtain good results, at the Ironclad mill. He is now installing another cyanide tank, which will increase the tonnage of the mill around 100 tons per day.

✦ The American Smelting & Refining Company has taken a lease and option on the Iowa Tiger mine, 4 miles up Arastra Gulch from Silverton. This is the second property the company has taken over in this territory. The Silver Lake and the Iowa Tiger mines together cover some two hundred patented claims.

✦ Andrew A. Zangara, general manager of the St. Joe Mining & Milling Company, has been made president and general manager of the Boulder Minerals Corporation, which is now engaged in the building of a 250-ton custom flotation-cyanide reduction plant at

Valmont. This plant will treat ores from many small operations in the Front Range.

✦ The American Smelting & Refining Company is enlarging an old 60-ton mill at Alice and expects to have a 200- to 300-ton mill in operation by early fall. The inclined shaft is being retimbered and mine development is under way. This property is located at the foot of St. Mary's Glacier, and is about 12 miles from Idaho Springs.

✦ The United Empire Gold Mines Company, at Sunshine, recently installed a 45-in. high-weir type Akins classifier in closed circuit with the Hadsel mill, which is reported to have greatly increased mill capacity.

Tri-State

Zinc Production Down

TEN-WEEK curtailment program is now in effect.

✦ Most of the larger companies of the district are curtailing output on a 50 per cent basis in an effort to cut the surplus stock of zinc concentrates in the district, which recently reached 42,000 tons, when several smelters with large stocks of ore on hand decided to liquidate these supplies. Production of zinc averaged only 5,500 tons a week in the first two weeks of July, compared with a normal of 10,800 tons, as a result of the curtailment program.

✦ The Mutual Mining Company, operating in the Oronogo district, has extended its operations to some of the acreage of the American Zinc, Lead & Smelting Company, according to W. Guy Waring, Oronogo. The Mutual recently leased 80 acres from American Zinc, Lead & Smelting. Extension of these operations in the Oronogo district has been offset by the closing of the Webb City Lead & Zinc Company's operations. The latter company will be idle until the ten-week curtailment program is consummated, according to John Skinner, superintendent, of Webb City.

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St. Joseph Lead Company

✦ St. Joseph Lead Company and subsidiaries reports a net profit for the first six months of 1936 of $647,175 after depreciation, obsolescence, and other charges. No provision was made for Federal surtax on undistributed profits. In the same period last year the company reported a loss of $78,398.

California

Long Tunnel Project For Lava Cap Mines

GOLD HILL MINE unwatered — Idaho Maryland Mines Co. plans to erect a new mill at Forbestown.

✦ Work on the 7,500-ft. tunnel to connect the Central and Banner shafts of Lava Cap Gold Mining Corporation, Nevada City, is now carried on in three shifts, and with a monthly advance of 400 ft. The undertaking is expected to be completed in six months. The mill is now treating 300 tons of ore a day. O. E. Schiffner is general manager.

✦ California Engles Company has completed unwatering the Gold Hill mine, near Angels Camp, and intensive development work is in progress. The property is one of three acquired recently by the company, and production is to be milled in the Belmont Osborn mill.

✦ The new dredge completed recently near Loomis by the Antelope Creek Dredging Company has been placed in operation and is reported to be working satisfactorily. Land holdings of the company comprise about 300 acres, assuring about six years of dredging. The dredge is of the bucket type and can handle 1,800 cu. yd. of gravel a day. Operations are directed by Thomas F. Nicholls.

✦ Construction work completed recently at the Zeibright mine, near Emigrant Gap, owned by Empire Star Mines, includes the erection of an 85-ft. steel headframe over the vertical shaft now being sunk to a depth of 600 ft., and the installation of a 250-hp. double-drum hoist. The cyanide plant for treating flotation concentrates started late in April is working satisfactorily. John N. Becker is superintendent.

✦ Idaho Maryland Mines Company plans to erect a 300-ton mill at its Forbestown operation provided road co-operation by Oroville and Butte County authorities is secured for building a road to the Forbestown mining area. Operations at Forbestown are directed by J. E. Ehrhorn, superintendent.

✦ Comanche Gold Dredging Company, operating a large dredge on the Foster Ranch, near Comanche, is reported to have increased its holdings in that area by the acquisition of 73 acres of placer ground from Roselle Lowthian for a consideration of $16,000. H. G. Peake, of San Francisco, is manager of the company.

✦ Dredge No. 19 of Yuba Consolidated Goldfields, operating in the Oroville dredging district, has been closed down temporarily for modernization and repair. Among other improvements the dredge is to have a new digging ladder. The boat was one of the three built during the World War and is able to dig 80 ft. below water. F. C. van Deinse, vice-president, is in charge of operations.

✦ A 30-ton rotary furnace was placed in operation recently at the Wide Awake quicksilver mine, near Wilbur Springs, Colusa County, by the Buckeye Syndicate, headed by L. R. Robbins and L. H. Baker, of Reno, Nev. The plant will be operated on dump material until the mine, which has been idle since 1900, has been unwatered and underground workings have been rehabilitated.

✦ It is understood in San Francisco mining circles that William R. Moorehead has purchased the New Idria quicksilver mines, near Hollister. Mr. Moorehead managed the property for many years when it was controlled by Boston interests.

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Homestake Gives Bonus to Employees

✦ The Homestake Mining Company, in Lead, S. D., recently distributed a bonus of $50 to all persons in the employ of the company as of April record. B. C. Yates, general manager, announced that about 2,200 employees will receive the bonus, involving an outlay of around $110,000. This is the fifth bonus paid by the company in the last two years.

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Labor Strike at Rio Tinto, Spain

✦ The strike which began at the Rio Tinto mines and railway on June 15 ended June 29, the 16,000 employees accepting the company's terms. After the Spanish general election last February, those of the company's employees who had been imprisoned following the abortive revolution in 1934 were released. The company was obliged to reemploy them and also others who had been discharged, including many who had been dismissed because they were not needed, the total number taken back being over 1,200. Terms offered the men's representatives on June 11 were accepted, but in mass meeting were rejected. The final acceptance of those terms ended the strike. On July 18, however, the company reported that a general strike was called. Since that time the rebellion in Spain has been so widespread that any strike settlements may be remote.

Arizona

Exploration of Manganese Deposits

PLACER OPERATIONS increasing in Lost Basin area.

✦ A large group of manganese claims situated in the Artillery Mountain country in southern Mohave County has come under the control of the M. A. Hanna Company, of Cleveland, Ohio, and an active exploration plan is being prosecuted by diamond drilling. The property is reached by road from Congress Junction and across the Bill Williams River at Alamo Crossing.

✦ Oro Rico Placers, situated in the Lost Basin area of Mohave County, are installing concentrating plants on their holdings in the upper stretches of Grapevine Wash. The equipment has been designed particularly to meet the requirements of the immense gravel deposits held by the company. Their acreage is adjoining the field now operated by the King Tut company, which has been steadily producing for the past several months.

✦ The Boriana mine, 26 miles from Yucca, Mohave County, is now the second largest producer of tungsten in the United States. It has been a consistent producer for several years. Recent developments in new ground make continued production possible for a considerable period.

✦ The Ripsey mine, at Kelvin, is planning the installation of a 50-ton concentrating plant. The mine has been making shipments of 50 tons monthly to the Magma smelter, at Superior. The ore is gold and silver.

✦ The Leadville mine, at Courtland, controlled by the Holmes Mining Company, is installing equipment for the operation of three shafts. During recent months the company has been unwatering some of the old workings, retimbering, and driving new drifts into orebodies recently disclosed. If developments are satisfactory, mill and flotation equipment will be installed.

✦ The Inspiration Copper Company, at Inspiration, is producing approximately 6,500 tons of copper ore daily. This is about 35 per cent of the capacity of the company's plant.

✦ The new 300-ton milling plant of the U. S. S. R. & M., at the company's Gold Roads mine, near Oatman, Mohave Count, is under construction. It is expected that the mill building will be completed and the machinery installed ready for production by early fall. The Gold Roads mine has been shipping 1,500 tons monthly to the Tom Reed mill, at Oatman. Developments, however, have been such as to warrant the company's installation of its own mill and treatment plant.

✦ The Tennessee-Schuykill property, at Chloride, Mohave County, is expected to start its mill on Sept. 1. The mine has been unwatered to below the 900 level and the stopes put in condition for production. This property was a steady shipper to the smelter at Needles, Calif., for a number of years, when the United States Smelting, Refining & Mining Company operated there.

✦ The Southwest Ore Corporation, operating the Las Guijas mine, in the Arivaca district, Arizona, is producing approximately 500 tons of tungsten ore monthly.

✦ Bagdad Copper Corporation, at Hillside, is increasing the crushing capacity of its mill. The present 250 tons daily will be stepped up to 500 tons. A molybdenum concentrate will be produced as well as the copper concentrate.

✦ The Tucson Ore Buying Company has established a branch at Aguila. This is the fourth custom ore market in the State.

✦ United Verde Extension Mining Company is reported to have had an output of 2,403,732 lb. of copper in May. This is an increase of approximately 10 per cent over the record for the preceding month of April.

✦ The Banner mine, in the Papago district, near Tucson, has installed a concentrator of 30-ton daily capacity. The Banner is a silver-copper property and has been shipping ore to the Tucson Ore Buying Company.

✦ The Octave mine, at Octave, operated by American Smelting & Refining Company, is augmenting its water supply by the installation of pumps to lift the water from an old inclined shaft on the property. The company is considering plans for the handling of custom ores.

✦ Excavations for a 200-ton concentrator are being made at Mayer by the Humboldt Mines, Inc. Dump ores are to be handled while further development is prosecuted. A Straub Rib-cone mill and flotation installation will be made.

✦ Gold Shares, Inc., representing Pittsburgh (Pennsylvania) capital, have taken over the Roadside mine, in the Katherine district, Mohave County, and development will be started soon. The Roadside has produced in excess of $200,000 during recent months, the ores being treated at the mill of Gold Standard Corporation at Katharine. Offices of the company are at 1,202 Law & Finance Building, Pittsburgh, Pa.

✦ Phelps Dodge Corporation and subsidiaries for the six months ended June 30, 1936, subject to audit and year-end adjustments, shows net profit of $4,666,330 after interest, depreciation, and other charges, but before deductions on depletion and exclusive of surtax on undistributed profits. This compares with earnings of $2,624,697 in the first half of 1935.

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More Gold Mine Exploration in Michigan

✦ The Norgan Gold Mining Company, incorporated under the laws of the State of Michigan, has been organized to explore for gold north of Ishpeming, Mich., on property belonging to the Ford Motor Company. A party of ten geologists and assistants are in the field, with Dr. W. A. Kelly, of the Geological Department of Michigan State College, East Lansing, in charge. The Ford company has a large acreage in the district to the north of Ishpeming. A favorable showing of gold-bearing rock has been found and a thorough survey will be made. More than 40 years ago there were several gold prospects in the area, and these will be investigated. The geological party will be on the ground until fall, but it is not believed the survey can be completed this year. Two mining companies are already operating on the Ishpeming range, both being farther to the south and west. They are the Michigan Gold Mining Company and the Ishpeming Gold Mining Company, the latter a subsidiary of the Calumet & Hecla Consolidated Copper Company.

✦ At the Ropes gold mine of Calumet & Hecla, in the Ishpeming district, two diamond drills are working underground. Surface drilling has been discontinued, but will be resumed later in the summer.

✦ After a lapse of several years, due to depressed conditions in the mining industry, the Lake Superior Mining Institute will hold a meeting this year, according to S. R. Elliott, of Ishpeming, Mich., president. The sessions will be held late in August on the Marquette range, with Ishpeming as headquarters. A. J. Yungbluth, of Ishpeming, is secretary of the Institute.

✦ The Michigan Engineering Society will hold its annual summer meeting in Houghton in September. The society holds two meetings a year, one in the winter and the other in the summer. It has approximately 900 members, having grown rapidly during recent years.

NEWS FROM WASHINGTON

By Special Correspondent

WHAT are the mineral reserves of the United States? What is the capacity for domestic production? In November, 1934, the National Resources Board and the Planning Committee for Mineral Policy directed the preparation of reports that would give reasonably comprehensive answers to these questions. The reports were compiled in 1935 by Kenneth Leith and Donald M. Liddell, respectively, and have now been published in consolidated form by the National Resources Committee, Washington, D. C. The consolidated report itself will have to be consulted for details on 31 metals and minerals, but some generalizations can be presented here.

The very nature of ore deposits makes predictions of their reserves hazardous. A coal bed or an iron deposit can often be measured with considerable accuracy. A gold mine, on the other hand, may consist of pockets of ore haphazardly distributed in a wide lode, and any estimate of the value of reserves must of necessity be uncertain. Again, although vein lodes have definite boundaries, many disseminated orebodies have indefinite limits, both as to quantity and quality. Here the reserves will vary with changing technological processes and economic conditions. Changes in industrial demand also affect the limits of available reserves. Thus, technology, price, and industrial demand all combine to make difficult the prediction of available mineral reserves.

Although opinions vary as to our knowledge of mineral reserves, the report gives the following list of minerals and metals in descending order of our knowledge of their available reserves:

1. Coal	16. Chromite
2. Iron	17. Rutile
3. Nitrates	18. Molybdenum
4. China clay	19. Manganese
5. Graphite	20. Tin
6. Sulphur	21. Antimony
7. Copper	22. Vanadium
8. Gypsum	23. Aluminum
9. Mica	24. Barite
10. Asbestos	25. Ilmenite
11. Potash	26. Zinc
12. Petroleum	27. Lead
13. Fluorspar	28. Silver
14. Nickel	29. Tungsten
15. Magnesite	30. Gold

31. Mercury

Coal is probably our most abundant mineral resource, and the reserves are believed to be sufficient to last 4,000 years. Iron ore, limestone, gypsum, aluminum, and molybdenum are also materials that will last far beyond the period for present concern. On the other hand, there are minerals whose reserve life can be calculated in decades, considering only their present rate of consumption and disregarding economic and technologic factors. Oil will probably last 40 years; lead, gold, and silver for a few decades only. Lead and silver could conceivably be exhausted in 20 years. Copper, zinc, and fluorspar will probably last longer than lead and silver, but the period before their exhaustion will be comparatively short. For another group of minerals the supply is already deficient; for others, such as nickel and tin, virtually non-existent. The deficient list includes manganese, chromite, vanadium, mercury, and tungsten.

Atmospheric Dusts

● A more intensive study of atmospheric dusts than ever before has been undertaken is being begun by the Bureau of Mines. Particle concentration, composition, and size will be studied. Dust particles will be magnified to 2,000 diameters in the study of the character of dust created by various operations in the mineral industry. The shape, hardness, and density of dust particles will be studied.

Among the methods that will be tried to control particulate matter in the atmosphere will be the ionization of air as a means of settling dust and the use of flocculent material to sweep dust from the air as does snow.

Capacity for Production

In discussing the matter of plant capacity, the report points out the necessity of a clear understanding of the interdependence of capacity and price. If the price of the product is high, more men can be put to work, operating loads can be increased, machinery can be speeded up, and obsolete equipment can be replaced. Hence in any discussion of capacity, the consideration of price is implied. Necessarily, it is not a simple consideration, but the fact remains that the capacity of a mine or plant is not the same at different price levels, but is a function of price. In this report various methods have been adopted to obtain plant capacity. Each mineral or metal has presented a separate problem and has been studied individually. Since, in large measure, the industrial production and consumption of 1928-1930 furnish the yardstick, the capacities discussed in the report represent the ability of the majority of the industries for continuous concurrent production.

R. F. C. Mining Loans

Mining loans in effect July 22 authorized by the Reconstruction Finance Corporation totaled $4,502,500. This total does not include applications granted but not taken up. A conspicuous example is the Consolidated Copper Mines Corporation, for which a loan of $3,000,000 was authorized but which the company did not use. A number of other applications authorized were not taken up. All such authorizations expire at the end of twelve months and are deducted from the total.

The principal cause of delay in disbursing the loans authorized is the inability of the applicant to establish his title to the property. Engineering examinations of properties are made promptly. The RFC now has three resident engineers in Arizona, two in California, two in Colorado and one engineer each in Idaho, Montana, and Alaska. If the application is sufficiently reassuring, examination is made by one of these engineers. If the application is approved, the actual expense of the examination and of the assays is deducted from the loan. In case the loan is not approved the loss is absorbed by the RFC. On the larger applications, engineering expense must be borne by the applicant, regardless of the action taken on the application.

The RFC cites several instances as examples of successful operations that have been made possible by these mining loans. The Humphreys Gold Corporation and the Porter Brothers Corporation have paid off their loans in full. An RFC loan has made possible the continuous operation of the Sutro Tunnel Coalition, Inc., property at Virginia City, Nev. With money borrowed from the RFC a 100-ton cynaide mill was built, which has made possible the profitable operation of the property.

The first development loan made was to the Southwestern Metal Mines, Inc. With the first $20,000 enough ore was uncovered to justify an additional loan of $65,000 for further development in the construction of a mill. Applications continue to be received for mining loans at the rate of one per day.

Mining Securities

Securities and Exchange Commission is proposing a new rule relating to exemptions for small issues of mining securities; also a new form and instruction book for their registration. The documents have been given a limited distribution among officials of Western mining companies for the purpose of inviting criticism and comment.

As explained by Commissioner Landis, the Commission is given power under the Securities Act of 1933 to exempt from registration issues of securities not exceeding $100,000. The proposed new rule of exemption is designed to bring greater simplicity in the treatment of such small issues.

"The principle of the new rule is that such small issues sold locally shall be exempt from *any* Federal requirements, if local requirements are complied with. As to issues of small amount—that is, less than $100,000—it is thought that Federal regulations should be waived, if compliance is had with the laws of the localities in which the securities are sold, since issues of such size are local rather than national in character.

"It is hoped that the combination of the exemption rule and the new form will afford a practical answer to the problems of the sale of mining securities. Upon the adoption of the new rule and form, if the issue is of small amount and is to be sold in one or two states, all that need be done will be to comply with the laws of those states; if the issue is to be sold in a number of states so that compliance with such local laws would be difficult, all that need be done is to file on the proposed form, in order fully to comply with the provisions of the Securities Act of 1933.

"The form is designed for securities of mining companies still in the promotional stage. Every effort has been made to meet the peculiar problems presented by this class of issuer. Heretofore such issuers have been required to register their securities on a general form which was not specifically adapted to their use. On that account certain difficulties of interpretation and adaptation arose. It is believed that the present form will obviate those difficulties. The information has been broken down into a number of items, which, it is believed, will greatly facilitate filing. There is to go with the form an instruction book, which is designed to be a clear-cut guide book in the preparation of any particular filing. In preparing the form, attention has been constantly given to the problems of the registrant. It has been sought to make the form and instruction book such that compliance with the provisions would not cause undue difficulty and would not take a disproportionate amount of time.

"It has been our purpose to place emphasis upon those elements as to which an investor would be primarily interested. Accordingly, the form is primarily concerned with the following heads of information: property, management, the development program, the uses to which the funds will be put, promotion, and the underwriting of the securities proposed to be offered.

"The property questions are designed to obtain a fair and adequate story of the pertinent facts which are definitely known. Where definite claims are made about tonnage, assays, or costs, they must be supported by the factual bases for such contentions. In that connection, mining properties in which sufficient development work has been done to disclose tonnages of proved and probable ore are treated differently from properties which are still relatively undeveloped. In the former case, it is comparatively easy to supply an assay map and such map is required. In the latter case, neither a detailed assay may nor a cost estimate is required, but only the customary surface and mine maps.

"As to the development program and the expenditure of funds, the requirements are flexible and can be easily adapted to meet the particular case. Estimates of expenditures may be set up by stages, and connected with the development programs to give the full story. It is realized, of course, that it may be impossible to state exactly the amounts which will be spent for the various items, and elasticity is provided in the requirement as to such information.

"In line with the policy of the Commission in all such matters, final action on the exemption rule and the mining form will be deferred pending a study of recommendations received from the group to which the rule and form are being sent. It is hoped that the rule and form can be adopted and published within the near future."

Electrometallurgy at Boulder Dam

● With manganese, chromium, molybdenum, tungsten, cobalt, nickel, magnesium, aluminum, and iron present in the formations near Boulder Dam, the new electrometallurgical experiment station of the Bureau of Mines at Boulder City hopes to determine the possibilities of low-cost production of these metals and their alloys when an abundance of cheap power is available.

Work will begin on manganese. An effort will be made to produce high-purity metallic manganese by electrolysis from solutions obtained by leaching low-grade ores. Experiments on a laboratory scale, conducted at the Reno station, indicate that this method has possibilities. It will be tried out at Boulder on a semi-commercial scale. Large-scale experimentation will be done on domestic chrome ores. Chromite will be smelted electrically in the presence of sulphides of iron and copper in an effort to produce an alloy of unprecedentedly high grade.

The work will be supervised by Dr. R. S. Dean, chief engineer of the metallurgical division. Dr. J. Koster will be in immediate charge. The bureau has purchased from the contractors the substantial building which they used as a garage and is installing the furnaces and such other equipment as can be bought with the money available.

As bureau officials believe better results can be obtained by concentrating the electrometallurgical work at one station, they have had to report adversely on a proposal to have such an experiment station established at the State College at Pullman, Wash.

Mines Bureau Reorganizes Technologic Branch

Coincident with the retirement of O. P. Hood as chief of the technologic branch of the United States Bureau of Mines and the appointment of A. C. Fieldner as his successor, the Bureau's technologic branch has been reorganized.

The name of the mechanical division is changed to the coal division and studies relating to the use of electrical and mechanical equipment in mines are transferred to the mining division. The experiment stations division is discontinued, and the coal preparation section of the experiment stations division and the experimental mine section of the office of the chief mining engineer are transferred to the coal division.

A new division called the non-metals division is created to take over the following technical sections of the discontinued experiment stations division: Fundamentals, Beneficiation, Processing, Utilization, and Water.

Hereafter, supervising engineers of the various experiment stations are to report to chief engineers of divisions as follows:

Pittsburgh Experiment Station to the chief engineer of the coal division. Minneapolis, Rolla, Salt Lake City, Reno, Boulder City, and Berkeley experiment stations to the chief engineer of the metallurgical division. Tucson Experiment Station to the chief engineer of the mining division. New Brunswick, Seattle, and Tuscaloosa stations to the chief engineer of the non-metals division. Bartlesville, Laramie, and Amarillo stations to the chief engineer of the petroleum and natural-gas division. Frank L. Hess, principal mineralogist, will report directly to the chief of the technologic branch.

The names and titles of the division heads of the technologic branch are:

Coal division, A. C. Fieldner, chief engineer.

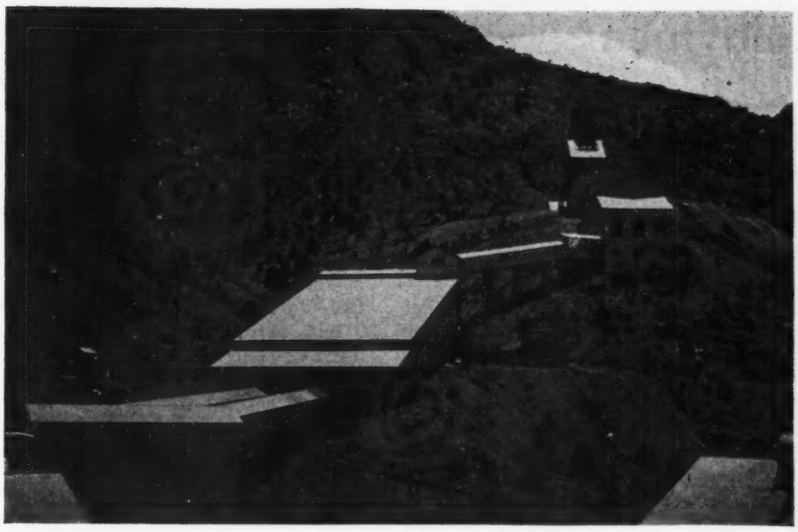
Explosives division, W. J. Huff, chief chemist.

Metallurgical division, R. S. Dean, chief engineer.

Mining division, C. F. Jackson, chief engineer.

Non-metals division, O. C. Ralston, chief engineer.

Petroleum and Natural Gas division, R. A. Cattell, chief engineer.



SHAFT, CRUSHING PLANT and 300-ton flotation mill of the Treadwell Yukon Company Ltd., at Tybo, Nev. Last year the main shaft was deepened 247 ft. to a total depth of 1,393 ft., and work done on the 1,160 ft. level has since intersected an orebody which is the downward extension of the Blackburn oreshoot. The mill treated 106,086 tons of ore during 1935

Nevada

Promising Development at Gold Standard Mines

LARGE mill to be built—Dayton Consolidated to reopen Kossuth mine

✦ After many months of development and sampling by means of shafts, tunnels, and core drilling, the Gold Standard Mines Company reports having blocked over 700,000 tons of gold ore of mill grade at the west base of the Humboldt range in Pershing County. A mill of large capacity is to be provided. Fire lately destroyed a large newly built bunk house, which is being rebuilt. The project is sponsored by the Lindgren-Swinnerton engineering concern, of San Francisco, and J. B. Stott is superintendent.

✦ Construction is soon to start on a mill of yet undetermined capacity at the Jumbo mine, north of Jumbo station, in Humboldt County, near the old Awakening district. The property was purchased from its two prospector discoverers by George B. Austin, merchant of Jumbo, and has been worked for the past year by Austin, his brother, and two sons. A small Straub mill, treating one to two tons per day of high-grade gold ore, has paid for the mine and equipment and supplied a surplus for larger plant construction.

✦ An option obtained by the Tonopah Mining Company covers a group of claims on which high-grade gold ore was found lately in the San Antone district, 30 miles north of Tonopah, by E. M. Booth, a Tonopah prospector. H. A. Johnson is in charge of the property for the Tonopah Mining Company.

✦ Dayton Consolidated Mines Company, operating the Dayton mine and 160-ton cyanide mill in Gold Canyon, below Silver City, Lyon County, is reopening the lately purchased Kossuth mine, adjoining the Dayton on the south. The bulk of mill feed, reported of high mill grade, comes from the Dayton mine, with around 30 tons per day from the leased Justice mine, above Silver City, and a smaller tonnage from the Kossuth. Dayton Consolidated lately secured a working option on three contiguous gold properties on the East belt of the California Mother lode, in the Garden Valley district, Tuolumne County. Homer L. Gibson is president-manager.

✦ Gold properties near Carrara, southern Nye County, embracing sixteen claims and including the Gold Ace mine, have been acquired under option by John W. Marshall, southern California mine and oil operator, who has announced that funds up to $100,000 will be provided for a cyanide mill of large capacity, replacing the present 60-ton plant. The present blocked reserve of ore, sampling $10.20 gold per ton, is placed at 300,000 tons by C. M. Hanselman, resident engineer. Pat Shea is superintendent.

✦ Weepah, Nevada's 250-ton amalgamation-flotation mill, described in detail in the June issue of *E. & M. J.*, is reported to be operating satisfactorily with gold recovery and costs lower than those first estimated. The ore zone has been stripped for open-pit operation for a length of over 1,000 ft., and at one point apparently is more than 100 ft. wide. Value of mill feed is said to be well above that indicated by sampling.

✦ At Goldfield the cyanide leaching plant of the Bradshaw Syndicate, Inc., is treating 1,400 tons of tailing per day from the long-dismantled 1,000-ton cyanide mill of the Goldfield Consolidated Mines, the tailing gold content ranging from 85c. to $1.20 per ton. Late in June the project paid a dividend of $15,000. President Bradshaw has indicated that the 1937 operation, on the present tonnage basis, may be expected to clean up the remaining impounded tailing of profitable grade.

✦ Final authority having been granted by the Federal District Court for reorganization of the Nevada State Gold Mines Company, successor to the Seven Troughs Gold Mines Company, officers announce that exchange of second preferred and common stock for outstanding bonds is being effected as a step preliminary to refinancing through the sale of first preferred stock to realize operating funds. It is the purpose to reopen deeper levels of the 750-ft. Taylor shaft and to sink it 500 ft. deeper. In late years the property has been worked with substantial profit by lessees.

✦ Properties of the Nevada Porphyry Gold Mines, Inc., including all productive ground at Manhattan, Nye County, have been optioned to men representing the A. O. Smith Corporation, a Milwaukee, Wis., manufacturing concern. Under the direction of George H. Garrey, consulting engineer for the Smith group, large-scale sampling has been conducted.

✦ A dividend at the rate of 2c. per share has been paid on 1,250,000 outstanding shares of stock of the Buckskin National Gold Mining Company, owner of the Buckskin mine, in northern Humboldt County, now operated under lease by the Nevada Lucky Tiger Company, subsidiary of Lucky Tiger-Combination Gold Mining Company. The owning and leasing companies share equally in net revenues from the 50-ton cyanide mill.

✦ New York men are said to be financing a plan to reopen the Eastern Star mine, at Gold Circle, western Elko County. The mine has been purchased from the Security Mining Company, headed by N. H. Getchell, president of the Gold & Silver Circle Mines Company, by Lenox H. Rand and associates. Following small production of rich gold ore, the Eastern Star was sold at sheriff's sale in 1928. It is about three miles east of the Elko Prince mine, is developed to the 300-ft. level, and is well equipped.

Idaho

Mine Employment Higher

DEVELOPMENT planned for Galena and Interstate Mines of Callahan Zinc-Lead Company

✦ Mines, mills, and smelters of the Coeur d'Alene district are now employing approximately 4,000 men, with about 300 additional working in small prospects or on their own claims. This is an increase of more than 1,000 men over the number employed a year ago, but is still 2,000 short of the peak employment period of pre-depression days. Higher prices for silver and a stronger market for both lead and zinc have brought about a gradual increase in the payrolls of the district, and the outlook is considered bright for employing 500 more with the anticipated resumption of some old-time producers which have recently changed hands.

✦ The Callahan Zinc-Lead Company recently closed negotiations with Frank Eichelberger, former manager of the Sunshine mine, whereby Mr. Eichelberger secures control of the company stock by purchasing 747,518 shares at $1 per share. An initial payment of $75,000 has been followed by another on July 31. The balance will be paid on July 31, 1939. Callahan Zinc-Lead operated the Galena mine, where work is now under way. Mr. Eichelberger is planning a comprehensive development program of the mine, calculated to place the property on a steady production basis.

✦ Jim Clark was the lucky placer miner who recently uncovered a gold nugget valued at $540 in the shallow diggings on Prichard Creek near Murray. The nugget is said to be the largest found in the district. It was shaped like a potato.

✦ The Sullivan gold property at Elk City expects to have the first unit of the mill ready for its initial tests around the first of August. Finances for operations have been furnished by residents of the Coeur d'Alene district. Mine development has revealed a body of gold-bearing ground in a well-defined vein, and operations will be extended to the 300-ft. level. Jean Peters is general manager.

✦ The four-compartment shaft at the Sunshine mine has now passed the 1,200-ft. level. The first working level from the new shaft will be on the 1,700, where crosscuts will connect with the vein. A raise, started from the 1,700 level to connect with the shaft, is rapidly nearing a contact, and the two will meet within the next ten days. Shaft-sinking operations will be expedited when the pilot raise from the 1,700 level connects with the shaft. Production continues at normal rate through the old shaft. In June, twelve cars of concentrates are reported to have yielded 640,000 oz. of silver, worth $492,800.

✦ Shaft-sinking operations are again under way at the Polaris mine. Joe and George Grismer, contractors, are in charge of the work. A 1,500-ft. raise near the main operating shaft is reported to have been in ore for the greater part of the distance. This has added to ore reserves for future milling operations. The shaft will have three compartments and will be sunk from the 920 level to 1,400 ft. below the level of the main tunnel, or 2,000 ft. vertically beneath vein outcrop.

✦ The Silver Crescent mine, on Moon Creek, will be further developed by a long crosscut from the 600-ft. level of the Charles Dickens shaft, according to an announcement by James Mohr, of Wallace, president of the company. The Silver Crescent and Dickens properties adjoin. Silver Crescent has a group of 19 claims and the Dickens has 24. The Dickens is equipped with a modern mill of 150 tons' daily capacity, and a three-compartment shaft 600 ft. deep. Ross Roundy, vice-president and general manager, states that as soon as the shaft is unwatered the 1,600-ft. crosscut will be started.

THE SOUDAN MINE, in St. Louis County, Minn., was first opened in 1884, and since that time has produced many millions of tons of iron ore known as Vermillion Lump, which is a hard, blue-steel, non-bessemer hemetite. The Oliver Iron Mining Company, of Duluth, operates the property

Iron Country

New Equipment Improves Production

RAILWAYS supply larger ore cars—Iron ore output continues at good rate

✦ No let-up is observed in iron-ore production at this time of the season. In fact, production must be increasing, as operators complain they are unable to get sufficient railroad cars and are forced to take a day off now and then. When boats do not arrive according to schedule, operators pile up so much ore on the docks that the railroad has to cut off the supply of cars to keep from swamping them. The new 75-ton ore cars purchased by the Great Northern are now being received and are a much improved design over the last ones purchased, as the trucks, brakes, drawbar equipment, and even the box show more sturdy construction.

✦ At the Bennett Mining Company, Keewatin, a new "Clipper" all-steel churn drill was received recently. This is the first one on the range and is equipped with drum for structure drilling. The machine has single caterpillar crawlers, and is designed heavier through all its drive mechanism to operate with a 25-hp. motor.

✦ At the Spruce mine a new Sauerman Scraper outfit with 3-yd. bucket has been placed in operation, as the mine is reaching a depth too great for cheap hauling with steam locomotives. It is an electric-driven outfit similar to the one used by the Miller mine, at Aurora, several years ago.

Copper Production Abroad To Be Increased

✦ Foreign producers of copper who are participating in the curtailment agreement will increase operations 5 per cent effective Aug. 1, 1936. This will bring the rate of capacity up to 75 per cent and will increase mine output in the foreign field by about 3,250 tons of copper a month. Braden and Chili Copper, in South America and Katanga; Roan Antelope and Rhokana, in Africa, will step up production according to the agreement, as these companies represent a major proportion of the foreign primary production.

Terms of the general agreement were signed on March 28, 1935, and became effective June 1 of that year, and, subject to certain contingencies, will continue until July 1, 1938. Opinion among producers is that the current rate of consumption of copper abroad is easily large enough to absorb the increased supply without weakening the price structure, especially with some doubt over the status of Spain as a producer under the difficult conditions in that country.

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More Ancient Mine Workings Found in Yugoslavia

✦ Trepca Mines Ltd.'s operations were practically back to normal in June, 48,457 tons of ore being milled. Production was 5,137 metric tons of lead concentrates assaying 79.48 per cent lead and 26.3 oz. of silver per ton, and 6,781 tons of 50.51 per cent zinc concentrates. Trepca is carrying out an interesting exploration on its Rogozna property. An ancient adit leading toward the mineralized zone has been reopened and is being extended. The pitted area on the surface is extensive, and a particularly interesting discovery is that the ancients had left some 10,000 tons of rich sulphide ore mined and ready for transportation.

✦ Kopaonik Mines, Ltd., advanced its deep adit 210 m. (689 ft.) in June. This adit will be 2,500 m. long and will reach its objective under the ore zone at a vertical depth of about 1,500 ft. It had already been driven 970 m. and should be completed in February, by which time the company will be starting production from the upper levels of its mine. This property is in Yugoslavia, near that of Trepca Mines, Ltd. The latter is now extending its mill to treat Kopaonik ores.

✦ Bor Mines has reached an agreement with the Yugoslav government and will erect an electrolytic copper refinery at Bor. It is planned for an annual capacity of 12,000 metric tons, and is expected to be completed next year.

Africa

Drilling in the Gold Coast Reveals Rich Ore

BROAD SCALE of development in the Northern Rhodesia copper mines

✦ A sensational discovery is reported by Ashanti Goldfields in the Gold Coast, a borehole having disclosed 6.6 ft. of reef assaying 122 dwt. Though the ore milled from this company's mine yields an average of approximately an ounce of gold per ton, it comes from a reef which is decidedly patchy. For instance, a recent development report tells of the reef being crosscut at fourteen different points, eleven of which revealed unpayable and only three payable values. But the fifteenth test of the same period was the borehole mentioned. Ashanti Goldfield's remarkable success has been due to the refusal of the management to be discouraged by long stretches of unpayable ground and by persisting till the rich shoots are found. It appears that it is due to the example set by this company that others in the Gold Coast region are displacing failure with success. Exploratory developments are continuing to be expanded.

✦ The Northern Rhodesia copper mining companies are continuing their broad scale of development work. Roan Antelope is persistently extending a drift to the west, and raising ventilating shafts far beyond the Storke Shaft. The total length of its underground openings is now just under 3 miles. A man shaft far to the west on the north wing of the ore deposit is already down approximately 1,500 ft. Mufulira Copper is similarly developing its mine years ahead of present requirements.

✦ In 1935 Union Minière du Haut-Katanga produced 107,682 metric tons of copper (rate of output having been reduced to 87,000 tons annually from June 1 by international agreement), 526 kg. gold, 28 kg. platinum, 159 kg. palladium, and 117,000 kg. silver, and also 1,029 tons of cassiterite. The quantities of cobalt and radium produced or sold are not given, but the report says the cobalt market continued to expand, and that the sales of radium remained at approximately the same level. Profit for the year, before interest and depreciation, was 176,695,412 francs, against only 76,670,385 francs in 1934, equivalent to $6,007,678, against $3,580,506 the preceding year, and dividends are resumed with the payment of 87.44 francs on the capital and divided shares. Ores and metals on hand were valued at 188,363,300 francs at the end, as against 279,345,422 francs at the beginning of the year. This considerable decrease was probably due largely to the reduced tonnages in process and in transit resulting from the smaller volume of production, and sales must have exceeded output. Only 993,000 tons of ore was mined. It appears that stockpiles and old tailings were drawn on heavily. Of the year's copper output 72,242 tons came from the blast furnaces and 35,440 tons from the leaching-electrolysis plant. The new concentrator at the Prince Leopold mine was completed and operated most of the year.

✦ The two boreholes put down on the Eileen Alannah under the direction of Cam and Motor engineers have been discontinued at depths of 766 and 960 ft., payable values not having been found. No other drilling is in progress.

✦ The first 52,500 tons crushed in the new 2,000 tons daily capacity mill of Rand Leases (Vogelstruisfontein) is reported to have yielded £81,048 worth of gold. This is just under 31s. per ton, and working expenses, including development, are given as 22s. ld. per ton. Milling operations began ten months after sod was turned for the foundation of the plant. This company's property is 1,933 claims between Durban Deep and Consolidated Main Reef. Its ore reserves are estimated as 1,848,000 tons averaging 4.6 dwt. per ton.

✦ Kimingini Gold Mining Company, operating in the Kakamega district of Kenya Colony, is getting better results due to increased development at depth. It milled 2,665 tons of ore in June for a recovery of 946.94 oz. of gold, or over 7 dwt. per ton.

✦ East African Goldfields reports that a hoist chamber recently excavated, samples 9.2 dwt. over a vein width of 68 in., and that an enlarged drive at E.1820 averages 17.7 dwt. over a width of 109 in.

✦ Rhodesia Broken Hill Development Company produced 1,710 tons of zinc, 105 tons of vanadium concentrates, and 14 tons of fused vanadium in June.

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High Grade Gold In Wales

✦ Great Britain seems likely to become a gold producer. Excellent values are being developed in the Roman Deep Mine, at Pumpsanit, Carmarthenshire, Wales. It is officially estimated that 44,000 tons of ore averaging 4.8 dwt. has been developed between the 100-ft. and 160-ft. levels. On the 260-ft. level the ore is declared to carry over an ounce of gold per ton, and 294 tons recently shipped to Germany for treatment yielded 260 oz. The results obtained from approximately 10,000 ft. of new workings are causing enthusiasm to run high, the opinion being expressed that Roman Deep may become an important gold producer.

Canada

Public Interest in Dominion Mineral Industry Grows

PROVINCIAL GOVERNMENTS prepare to prevent speculation boom in mining shares—British Columbia's gold production increasing

✦ Though Federal and provincial governments have for many years taken an active and intelligent interest in the mineral industry, it is only during the past year that this interest has been displayed to the Canadian public in such a way as to attract popular attention and to invite public confidence. T. A. Crerar, Minister of Mines at Ottawa, has taken the lead, and the gist of his numerous public addresses has been to the effect that mining, a great basic industry second only to agriculture, can be developed by means of businesslike and vigorous methods into the Dominion's most prolific source of wealth, and that this is the task of the present generation. Today a substitute must be found for the much-diminished export market for Canadian wheat, and an enlarged domestic market for agricultural products must be made. The mineral industry can provide for both these needs, and already is doing so in such substantial measure as to attract widespread attention. The various governments are also taking steps to forestall a speculation boom in mining shares and to foster the idea that mining, as an industry whose success is vitally important to the Dominion, must be conducted on sound, businesslike lines.

Ontario

✦ Plans have been prepared for a 200-ton mill at Delnite, in the southwestern part of the Porcupine camp, following the development of 1,670 ft. of ore in drifts to 375 ft. in depth. Further ore will be developed before mill construction starts. The parent company, Sylvanite, has increased its mill capacity to 450 tons, following the discovery of new ore of half-ounce grade in substantial volume at the upper levels in the northern part of the ore zone.

✦ Bidgood, the most easterly producer of the Kirkland Lake camp, is now treating 75 tons daily of half-ounce ore. Provision has been made for an early increase in mill capacity. Oscar Knutson, manager, has been appointed vice-president of the company, following his remarkable success in bringing the mine to the point of profitable production.

✦ The mill at Omega, in the Larder Lake field, now treating 350 tons of $7 ore for a small operating profit, is being enlarged to treat 600 tons daily.

✦ North Whitney Mines has been organized by Quebec Gold Mining Corporation to develop ground in the Porcupine camp adjoining Pamour on the northwest. R. M. Macaulay is manager of all three companies.

✦ Sturgeon River Gold Mines, sole survivor of the boom in this locality three years ago, is now operating its 40-ton mill on half-ounce feed. The high-grade vein is narrow and dilution is kept to a minimum by sorting out as much rock as possible.

✦ The dimensions of the medium-grade orebodies recently disclosed on McLeod-Cockshutt, in the Little Long Lac field, are indicated by the announced intention of the company to prepare for a 500-ton mill. A new four-compartment shaft is being sunk to exploit the new deposits.

Quebec

✦ Sigma, subsidiary of Dome Mines in the Harricana camp, has now sufficient ore of $9 grade developed to its lowest level at 475 ft. to warrant a 500-ton mill. But, with its usual caution, the management is now sinking to 1,000 ft. to make sure the production zone extends to that depth before commencing mill construction.

✦ Siscoe has now attained a steady output of $14.50 a ton from 475 tons daily. The extraction has been raised to about 98 per cent.

✦ O'Ruin Gold has found, for the third time, a shoot of ore of remarkable richness, similar in grade to the original surface showing but apparently of greater extent. The high-grade has now been opened on four levels from 6th to 8th. The mill is so designed as to take out the nuggety gold as a jig concentrate for barrel amalgamation.

✦ Lake Rose is now sinking to open two levels below the adit level. High-grade ore has been exposed with a width of about two feet in this working and in the 140-ft. raise which takes the shaft to surface.

Northwest Territories

✦ Eldorado's silver-radium mine on Great Bear Lake is now in the profit-making class, the net earnings for 1935 being announced as $138,573. The mine output was 14,402 tons, yielding pitchblende and silver concentrates valued at $752,918. Concentrate shipped to the refinery at Port Hope, Ontario, was 147.8 tons. The mine is now partly developed to a depth of 500 ft. below adit level and is in a position to feed a concentrator larger than that of 75 tons daily now in operation. The refinery has now produced 22 grams of radium, and there is an assured supply for many years to come.

✦ The gold output of the Yukon is mounting steadily once more, principally as a result of increased dredging operations. Last year five dredges were in operation; this year there are seven and two more are on order to be in operation next season.

British Columbia

✦ The value of the Province's mineral production during the first six months of 1936 was $23,722,299, as compared with $21,672,674 in the corresponding period of last year, the increase being 9.4 per cent. This has been accomplished despite the closing of the largest copper mines in the province of Anyox, and the fall in the price of silver. On the other hand, gold output from lode mines increased from 161,200 oz. to 188,000 oz., and the volume of placer gold recovered increased from 7,000 to 10,500 oz. It is believed the production of placer gold this year will be the greatest in two decades. Total value of lead and zinc has increased as a result largely of improved prices for these metals. Coal output was the greatest since the first half of 1933, the increase as compared with last year being 12 per cent. Value of production during the first half of this year was $2,890,000. Value of structural materials produced increased to a similarly gratifying degree.

✦ American interests recently optioned stock in Reliance Gold Mines, in return for which they undertake to furnish $150,000 within the next two years. According to the president, John R. Seymour, it is proposed to construct a 100-ton mill. The Reliance mine is across the Bridge River from Minto.

✦ A new 25-ton Hadsel Hi-speed, dry-grinding type mill has been installed at the Ashloo Gold property, 30 miles from Squamish at the head of Howe Sound.

✦ According to the managing director, R. R. Rose, the capacity of the Cariboo Gold Quartz mill has been increased to 200 tons. Upon completion of the new power house in the middle of June, milling was resumed at the rate of 150 tons a day, and to the end of June, 2,296 tons was treated, from which 847 oz. gold and 100 oz. silver were produced, valued at $33,145.

✦ At the Minto mine, in the northern part of the Bridge River field, a level has been commenced from the foot of

a winze sunk 143 ft. below the River tunnel, in which high-grade ore has been followed for a distance of 330 ft. On the new low level, at a distance of 36 ft. from the winze, values were encountered, which improved to about 1 oz. at 50 ft., and 1.25 oz. at 110 ft. The mill is being operated at 120 tons daily, and mill feed during the first half of July averaged about .5 oz. D. N. Matheson is general manager.

✦ At the Island Mountain, across Jack of Clubs Lake from the Cariboo Gold Quartz, 3,947 tons of ore was milled in June, and 1,595 oz. gold produced, of a value of $55,825.

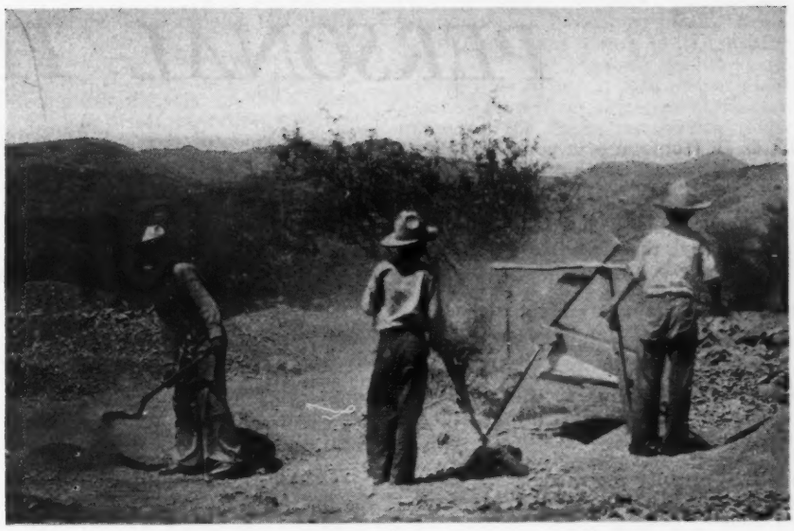
✦ Vidette Gold Mines, operating at Savona near Kamloops, recently concluded an option agreement with Vancouver interests for the provision of $150,000. A new ball mill is being installed and other adjustments made to increase the capacity of the plant from 35 to 80 tons. According to the managing director, G. F. Dickson, 683 oz. gold was produced from 819 tons of ore in June.

✦ In the annual report of Sheep Creek Gold Mines it is stated that in the period from May 20, 1935, when the 150-ton mill commenced operations, to the end of May, 1936, revenue was $544,655. Operating profit was $263,759, and net profit after all deductions was $108,680. Ore treated aggregated 51,022 tons, and 15,557 oz. gold and 4,643 oz. silver were produced. According to information received from the superintendent, H. E. Doelle, the east drift at the new 10th level has been carried over 100 ft. through ore.

✦ Preparations are being continued at the Kootenay Belle mine to increase the capacity of the mill from 50 to 100 tons. Recovery averaged $19 per ton of ore milled, and the operating profit was $29,395.

✦ In the Ymir area, Nelson district, at the Wesko, construction has been started on a 100-ton mill, which is to be completed by Oct. 1. A 2,800-ft. tramway is being built from the portal of the 560 tunnel to the millsite, and a bridge has been constructed across the Salmon River to the Great Northern Railway and the Nelson-Spokane highway. Reserves are estimated in the annual report of the consulting engineer, Arthur Lakes, at 32,918 tons above the 300 level, averaging $14.25 per ton, and 27,167 tons between the 560 and 300 levels, averaging $13.70 per ton, the total value being approximately $842,000.

✦ At the Bayonne, on the west side of Kootenay Lake, in the Nelson district, a 50-ton cyanide plant is being erected. Ore reserves in sight are estimated to be 21,827 tons, averaging 0.62 oz. gold, of a gross value of approximately $497,000. Further possible reserves are estimated to have a value of $448,000.



H. H. Taft, El Paso, Texas.

MEXICAN PLACER MINERS near Baradon, a few miles north of Nacozari, Sonora, recover gold in spite of drought conditions. About 400 Mexicans are working dry placers in this district. They operate in small groups like the one shown above. Moist, clayey gravel dug from the shallow shafts is dried in the sun and then broken by pounding. The lighter material is separated by means of bellows and the concentrate is then carefully washed for gold.

Mexico

Mining Companies Affected by Power Strike

ORE AND SUPPLY transport by airplanes planned by company in Durango

✦ Midsummer found the Mexican mining industry carrying on comparatively normally and enjoying a relative surcease from direct labor troubles. Difficulties with help were smoothed over by allowing workers' demands and increasing wages in some instances and with intervention of the Federal Labor Department warding off strikes by inducing disgruntled employees to accept parleys in others.

✦ Companies not operating their own power plants were more or less acutely embarrassed by the strike of electricians of the Mexican Light & Power Company, Ltd., which monopolizes current service in the Federal District, Hidalgo, Puebla, Mexico, Michoacan, and parts of Guerrero and Vera Cruz, supplying 65 per cent of this country's commercial electricity. Several mining companies, mostly small enterprises, were among the 3,200 industries affected in the strike belt. The trouble put two flotation plants at Loreto, Hidalgo, temporarily out of service. Following a strike settlement late last month, power was restored and normal operations were resumed. A controversy followed, however, as to whether mining companies should pay employees for the time they were made idle by the strike. It is believed that the precedent established by the Mexico Tramways Company in paying wages during the strike will be followed by the mining companies effected.

✦ Work has been resumed at the Tetipac property, Guerrero, of Cia. Minera de Montecarlo y Anexas, S. A., as a result of the Federal Labor Department coaxing dissatisfied workers to abandon strike plans and accept arbitration.

✦ Exploitation of gold-silver properties in the Tepehuanes district, Durango, is to be undertaken this summer by Cia. Minera San Jose de Llanitos, S. A., says Lawyer Guillermo Vallejo, representative. Plans include constructing a landing field to accommodate planes used in moving ore and supplies. The company operates mines at Cardenena, San Roman, Pilares, Topis municipality, and Durango.

✦ Cia. Minera Refugio y Virginia, S. A., owner of gold-silver properties at La Reforma, Hidalgo, must pay the Ministry of Finance 129,554 pesos (some $35,000 U. S.) as income tax, a Mexico City district court ruled. Company appealed the tax claim on the ground that the impost was excessive.

✦ Difficulties with workers were settled by Guanajuato Consolidated and Guadalupe, S. A., operating in Guanajuato, by agreements made at conferences with representatives of their employees, called by the Federal Labor Department, which permit them to lay off temporarily 95 of their 500 miners, in view of companies' economic condition.

PERSONAL ITEMS

Louis D. Huntoon is in northern Quebec and western Ontario on professional work.

R. K. Stockwell has returned to Shanghai after three months in Malaya and Borneo.

Henry Cribb is now mine manager of Gordon Gold, N. L., at Balwarrah, Victoria, Australia.

Prof. W. G. Sutton has been elected president of the South African Institution of Engineers.

H. L. Connolly is manager of New Harbour Tin Development, N. L., at Port Davey, Tasmania.

J. M. White has resigned as general manager of Takuapa Valley Tin Dredging, N. L., operating in Siam.

Sir George Albu, Bart., has been elected chairman of General Mining & Finance Corporation, South Africa.

Roy Edwards has taken a position as master mechanic with the Hammon Consolidated Goldfields, Nome, Alaska.

E. E. Gregory has been designated as mining commissioner for the district of Klerksdorp and assistant inspector of mines.

F. S. Mance has resigned the post of under-secretary of New South Wales Department of Mines, after 46 years' service.

Dr. F. S. Miller, mining geologist with Western Mining Corporation, Western Australia, recently returned to the United States.

Ing. Evaristo Araiza has assumed the duties of general manager of the Cia. Fundidora de Pierro y Acero de Monterrey, S. A., Monterrey, Nuevo Leon.

J. N. Ong, of Mufulira Copper Mines, Ltd., Mufulira, Northern Rhodesia, is spending his long leave in the United States. He expects to return to Rhodesia in November.

Gerald G. Dobbs has resigned as general manager, Ariston Gold Mines (1929) Ltd., Prestea, Gold Coast, West Africa, and has returned to Toronto, Canada.

A. Claud McDonald has left the metallurgical staff of Broken Hill Associated Smelters, Port Pirie, Australia, and joined Wiluna Gold Mines, Ltd., Wiluna.

A. E. Dainton, former manager of Gordon Gold, N. L., Australia, has been appointed manager of South New Moon, N. L., Bendigo, succeeding **W. L. Vale.**

E. Broadhurst has been made assistant senior geologist to the North Australian Aërial Geological and Geographical Survey. He will be stationed in Queensland.

Dr. A. C. Fieldner has been appointed chief of the technological branch of the United States Bureau of Mines, succeeding Dr. Ozni Porter Hood. He has also been named as the new president of the American Society for Testing Materials. Following his graduation in chemical engineering from Ohio State University in 1906, Mr. Fieldner became fuels chemist in the United States Geological Survey at Pittsburgh, Pa. In

DR. A. C. FIELDNER

1910, when this work was transferred to the newly created Bureau of Mines, he was placed in charge of the fuels chemical laboratory and later of the gas investigations laboratory also. During the war, he was in charge of the gas mask section, Chemical Warfare Service, and was commissioned a major. Dr. Fieldner returned to Pittsburgh as supervising chemist of the Pittsburgh Station, and in 1921 was placed in charge of the station. In 1925 he was appointed chief chemist of the Bureau of Mines, and in 1927 was placed in administrative charge of the Bureau's Experiment Stations Division, with headquarters in Washington, D. C. He has been chairman of the chemical committee of the American Gas Association and of the gas and fuel division of the American Chemical Society. He is a member of the A.I.M.E., the American Chemical Society, American Gas Association, Coal Mining Institute of America, American Institute of Chemical Engineers, and of the following clubs: Chemists (New York); Cosmos (Washington) and University (Pittsburgh).

Dimitry Niconoff, metallurgist, and **J. G. Donaldson** and **L. H. Berkelhamer** have been appointed to the technical staff of Battelle Memorial Institute at Columbus, Ohio.

M. W. MacAfee, metallurgical engineer, Pan American Engineering Corporation, Ltd., has returned to his Berkeley (Calif.) headquarters from a business trip to Arizona.

James Needham, formerly with South American Development Company at Portovelo, Equador, S. A., has sailed for Manila, P. I., to join the staff of the Marsnia Mining Company.

Ray Erwin Swift has been made superintendent of the Michigan Gold Mining Company, which is operating a property 6 miles west of Ishpeming, Mich., and 2 miles west of Route 41.

Will Hattam, formerly with the American Zinc, Lead & Smelting Company, is now superintendent of mines for the Pend Oreille Mines & Metal Company at Metaline Falls, Wash.

Norman L. Wimmler, consulting mining engineer, has returned to his office, 74 New Montgomery St., San Francisco, Calif., after several months of professional work in Colorado and Wyoming.

Ernest Williams recently retired from the position of general manager of Great Boulder Proprietary Gold Mines, Ltd., Kalgoorlie. **James R. Halton,** assistant general manager, has taken his place.

Neville S. Spence, formerly of the department of metallurgy, Queens University, Kingston, Ontario, has recently returned from Europe and has joined the staff of the Ontario Refining Company at Copper Cliff.

T. Skewes Saunders, consulting mining engineer of Mexico City, was reported recently by the press to have been the victim of a hold-up by bandits in the district adjacent to Cuernavaca, south of Mexico City.

Wallace A. Coltrin, graduate of the University of Nevada, has joined the staff of San Mauricio, operating in the Philippines, as shift boss. His mining experience has been in Mexico and in the western United States.

Walter A. RuKeyser has relinquished his position of president of Minefinders, Ltd., but will continue as consulting engineer, giving especial attention to Montague Gold Mines, in Nova Scotia, and Tashota Goldfields, Ltd., in northern Ontario.

Carl Zapffe, manager of iron ore properties for the Northern Pacific Railway Company, living in Brainerd, Minn., was recently chosen one of the 91 Rotary International district governors. His district comprises North Dakota, Minnesota, and Superior, Wis.

Charles H. Thurman, Folsom, Calif., has resigned as superintendent of Gold

Hill Dredging Company to enter consulting work. He has established offices at 420 Market St., San Francisco. Mr. Thurman is also president of the Snelling Gold Dredging Company, active in the Snelling placer area.

Stanly A. Easton, president of the Bunker Hill & Sullivan Mining & Concentrating Company, at Kellogg, Idaho, has been named chairman of the program committee for the American Mining Congress' annual Metal and Mining Convention and Exposition to be held at Denver, Sept. 28 to Oct. 2.

H. W. Harrison, of Miami, Ariz., has been made general superintendent of the properties of the Commerce Mining & Royalty Company, to succeed **F. H. Gartung,** resigned. Mr. Harrison has announced the appointment of **S. S. Clark** as general ground foreman and **Elmer Isern** as chief metallurgist.

George R. Schaefer, of the 1936 class at Lafayette College, Easton, Pa., has accepted a position with Minas de Matahambre, a mining company operating in Cuba, and **Louis F. Fow,** of the same college and class, has joined the staff of the Alan Wood Mining Company at the Scrub Oaks iron mine, at Dover, N. J.

C. B. Larson arrived in Manila on April 30 to join the staff of the United Paracale Mining Company as mine superintendent. A graduate of the Colorado School of Mines in 1923, he has had mining experience in Arizona and in Mexico. He came to the Philippines after ten years with the Cia. de Real del Monte y Pachuca.

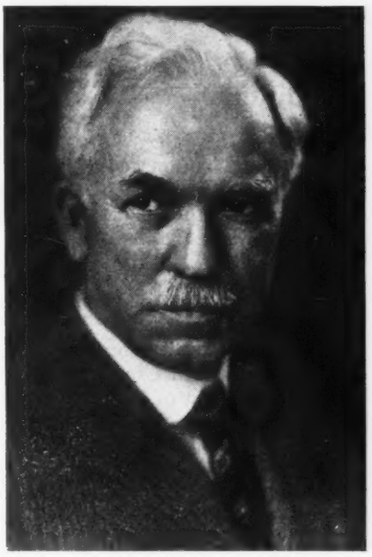
Waldemar F. Dietrich, one-time professor of mining engineering at Stanford University, has resigned from his position of associate metallurgist at the United States Bureau of Mines, to join the faculty of Sacramento Junior College at Sacramento, Calif., where he will develop a two-year curriculum in mining and metallurgical technology.

Henry Ross Taylor, formerly of Granby Consolidated, who has been doing consulting work in Vancouver, B. C., for the past year, was recently appointed manager of the Norcal Mining Company, at Sawyer's Bar, Calif. The property is being developed and diamond-drill work is contemplated. The 75-ton mill is being operated at its full capacity.

H. W. Chadbourne and **Scott Turner,** of the International Mining Corporation, recently returned from a mining trip to Canada. **James S. Wroth,** also of the same organization, has just returned from an inspection trip to Colorado and Montana. **J. C. Brennon,** also of the Corporation, has left New York for an inspection trip taking him into Costa Rica, Panama and Colombia.

E. C. Bitzer, assistant mill superintendent at Balatoc, has been promoted to mill superintendent at Cal Horr, where a new 150-ton cyanide plant was recently put into operation. **B. D. Harden,** mill shift boss at Balatoc, has been promoted to assistant mill superintendent. **W. A. Linfesty,** former mill superintendent at Cal Horr, has taken a similar position at Antamok Goldfields.

Dr. Ozni Porter Hood, chief of the technical branch and chief engineer of the mechanical division of the United States Bureau of Mines, retired on June 30, following 25 years of service with the Bureau. A farewell luncheon, attended by more than a hundred associates and former associates, was given in his honor at the Hotel Harrington, Washington, on June 27. Dr. Hood was born in Lowell, Mass., on June 14, 1865, and was educated in Worcester and Rose Polytechnic Institutes. He joined the Pittsburgh Experiment Station of the Bureau in 1911. In 1918 he was called to Washington to meet widespread demands on the Bureau in the fields of fuels and mechanical equipment. In 1926 Dr. Hood again responded to the needs of the Bureau in accepting the additional duties of chief of the technological branch. His retirement completes a quarter century of service in which his administrative ability, technical achievements, and high position in his profession have brought to him notable honors and distinction. He was made a life member of the American Society of Mechanical Engineers in 1935, and in 1932 his Alma Mater, Rose Polytechnic Institute, conferred on him the honorary degree of Doctor of Engineering.



DR. OZNI PORTER HOOD

A. V. Taylor, Jr., is now acting as superintendent of Quartz Hill Mining Company, 12 miles south of Divide, Mont., of which **Selden S. Rodgers,** of Anaconda, is general manager. Mr. Taylor is also a member of the partnership of Taylor, Nelson & Knapp, who are operating the Two Percent mine, at Philipsburg, Mont., which is now shipping a thousand tons per month of silver ore. With **R. H. Nelson,** he is also occasionally engaged in consulting geological examinations.

Lawrence B. Wright and **Samuel H. Dolbear** have jointly been designated as consulting engineers for the Anglo American Mining Corporation, Ltd. This company operates the Yellow Aster mine, at Randsburg, Calif., treating 6,000 tons per month in its crushing plant and 30,000 tons per month in its cyanide operation. It also operates the Oceanic quicksilver mine, in California, producing 160 flasks per month. The company has a substantial holding in the Carson Hill mine, treating 20,000 tons per month from its mines at Melones, Calif.

OBITUARY

William M. Bloomer, a pioneer in the Colorado mining field, died recently in Boulder.

Edward S. DeGolyer, a mining man of Arizona, died on June 9 at his mining property near Phoenix.

Walter W. Davis, former mining enginner, retired, died at Great Neck, L. I., recently, in his 73d year.

R. A. Clinton, for many years prominent in the mining development of Australia, died recently at Melbourne.

Henry Foote, long associated with mining on the Comstock Lode, died recently at Virginia City, Nev.

William B. Bourne, veteran California mine owner and operator, died at his home in San Mateo on July 5, aged 75.

Dr. Theodore Simons, professor of mining engineering at Montana School of Mines, died recently at Butte, Mont., at the age of 79.

Alexander P. Karpinsky, geologist and president of the U.S.S.R. All-Union Academy of Sciences, died in Moscow on July 14 at the age of 90.

Charles A. Brockington, veteran mine operator in the Grass Valley-Nevada mining area, died in Grass Valley, Calif., recently. He was 75 years old.

William Maguire, long identified with hydraulic mining operations in Nevada, Placer, and Siskiyou counties, died recently in Nevada City, Calif., at the age of 75.

The Hon. Lionel Holland, chairman of Mysore Gold Mining Company and Ooregum Gold Mining Company, and interested in many other corporations, died recently at the age of 71.

Roger Dennis, assistant superintendent at the Beebe Gold Mining Company at Georgetown, Calif., was killed by shock from contact with a high-voltage cable on June 14. Mr. Dennis was 28.

Alexander McDonald, of the electrical engineering staff of American Smelting & Refining at Angangueo, Michoacan, died recently in Mexico City, aged 36 years. He was born in Zumpango, Mexico State, of British parents.

Herbert F. Carter, a mechanical engineer for many years in the service of Rio Tinto, in Spain and United Mines, in Guanajuato, died recently in Mexico City; aged 81 years. He was a native of London, England, and had lived in Mexico since 1887.

NEW BOOKS

Law for Engineers

LEGAL AND ETHICAL PHASES OF ENGINEERING. *By C. Francis Harding and Donald T. Canfield. McGraw-Hill Book Company, New York, N. Y. Pp. 432. Price $4.*

This is primarily a "law book" for engineers. That it is good law may be accepted as fact without a lawyer's viewpoint, but it has one outstanding advantage over most law books. It is written by two engineers who teach law and it is written in language that engineers can understand, which is rare enough to merit comment.

The authors, who are prominent electrical engineers, on the faculty of Purdue University, state that the subject matter of the book has been used for many years in the senior engineering course to acquaint every student with some of the most important legal and ethical principles with which he must be familiar in the successful practice of his profession.

It is admirably adapted to that purpose. It is, however, far from the usual college textbook. So far, indeed, that harking back to my own college days, I suspect that the students in that course consider the going a bit tough. But that is a double virtue so far as the book is concerned and widens its usefulness to the professional engineer even of considerable years of experience.

Part I is devoted to the broad principles of law and Parts II and III to the law as applied to engineering contracts, specifications, estimates, patents, industrial hazards, employment, compensation, and related subjects. I am tempted to submit as my review the complete index. Only in this way can its wide scope and general value to the practicing engineer be indicated. Coupled with this is the fact that it is written in engineering English which can be understood without consulting another lawyer.

The last section, Part IV, deals with the engineer's relations with the public, legally and ethically, and with "Engineering Ethics" within the profession. As to the latter, the only dry section is the code of one national society quoted in full. Perhaps a code must be a series of do's and dont's, but the authors' discussion of engineering ethics is not only illuminating, instructive, and sound, but also is highly human and entertaining. Despite the fact that I consider the ethics of the engineering profession higher than those of any other profession, it might not be unwise to have every engineer read this chapter once a year, just as they read the Articles of War to a soldier every so often, lest he forget.

The book is replete with valuable references, which are made doubly useful by being compiled at the ends of the chapters.

And then there are the Appendices, comprising nearly 200 pages, covering typical forms, specifications, negotiable instruments, contracts, an abstract of a state compensation law, and complete specifications for a private dwelling and other types of construction and building.

Not only the young but also the mature engineer will find this book a valuable addition to his working library.

PERCY E. BARBOUR.

New York, N. Y.

New Edition

MINERALOGY. *By E. H. Kraus, W. F. Hunt and L. S. Ramsdell. McGraw-Hill Book Company, New York. Pp. 638, illustrations 812. Price $5.*

This is the third edition, extensively revised by the authors and wholly reset by the publisher. The first edition was published in 1920, and the second in 1928. The book is designed as a text for beginning students in the subject, and is the outgrowth of long experience of the authors as teachers in the University of Michigan. Accordingly, the presentation is simple and direct. Notable revisions have been made in the chapters on physical properties, the polarizing microscope, crystal structure and X-ray analysis, and the formation and occurrence of minerals. The text is followed by a glossary, a tabular classification of the elements of symmetry and the simple forms of the 32 classes of crystals, and tables for the determination of 150 minerals.

Good English

ENGLISH IN BUSINESS AND ENGINEERING. *By Brenton W. Stevenson, John Reed Spicer, and Edward C. Ames; with a Foreword by C. F. Kettering, Vice-President and Director General Motors Corporation. Published by Prentice-Hall, Inc., 70 Fifth Ave., New York, N. Y. Pp. 365. Price $2.25.*

Not theoretical assumptions but statistical data indicating a need for better education of engineers in the fundamental principles of English composition and expression guided the authors in their conception and creation of "English in Business and Engineering." As a result of research they declare, "English is an indispensable tool not only of the graduate who is making a place for himself in the profession, but also of the student who is preparing to enter a field in which only the fittest can survive."

For many decades colleges which specialize in the teaching of the engineering professions have condoned a tendency on the part of students of engineering subjects to gloss over advanced study of English, on the erroneous assumption that the he-men of the wide and open spaces which they send forth to conquer nature will require none of the polish and fluency which a major course in English connotes. This convenient and lazy habit has produced results unfortunate to the individuals concerned and to their adopted professions. The authors recognize and condemn past errors and pedagogic laxities in curricula, and step by step supply study material in the uses of our language, especially selected to cover every need that the engineer and the business man are likely to experience.

The work is divided into ten chapters, the titles of which are recorded to indicate the breadth and scope of the subject-matter covered: I, Requirements of the Business Letter; II, The Letter for a Specific Purpose; III, The Research Article; IV, The Written Report; V, The Press Release; VI, The Spoken Word; VII, Straight Thinking; VIII, Integration; IX, Mechanics; X, Basic Materials.

The authors of the volume have done a good job—timely and admirably suited to supplement many other excellent books on the technical use of English now available but not as popular as they should be and must become if all types of engineering students are to fare forth on graduation adequately equipped for those opportunities which beckon to them.

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PUBLICATIONS RECEIVED

Geology of Ventersdrop, With Geological Sheet No. 53. Geological Survey, Department of Mines, Pretoria, South Africa. Price 5s., including map.

Provisional Geological Map of Tanganyika, with Explanatory Notes. By E. O. Teale. Bulletin No. 6, Geological Division, Department of Lands and Mines, Dar es Salaam. Pp. 50, with two maps. Price 4s.

Patents on Geophysical Prospecting Issued in the United States, England, Canada, Australia, Germany, France, and Russia. By W. Ayvazoglou. Information Circular 6883. U. S. Bureau of Mines, Washington, D. C. Pp. 136.

Prospecting for Lode Gold. By E. D. Gardner, and **Locating Claims on the Public Domain,** by Fred W. Johnson. Information Circular 6843. U. S. Bureau of Mines, Washington, D. C. Pp. 18.

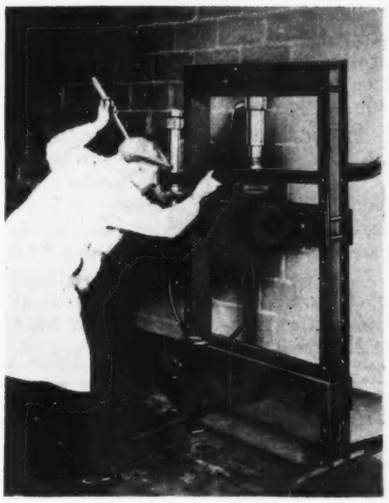
Alums and Aluminum Sulphate. By John B. Umhau. Information Circular 6882. U. S. Bureau of Mines, Washington, D. C. Pp. 32.

Tennessee Valley Authority, Geologic Work of the, 1933-1935. Preliminary and confidential report by Edwin C. Eckel, chief geologist of the Authority. Pp. 20 (typewritten).

EQUIPMENT NEWS

Portable Hydraulic Jack

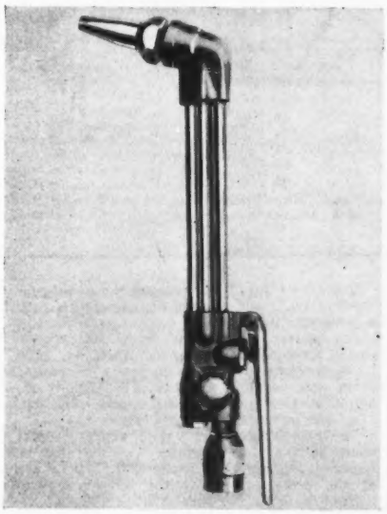
Development of a 20-ton capacity portable hydraulic jack for heavy-duty work has been announced by the Blackhawk Manufacturing Company, Milwaukee, Wis. The jack is a unit of the Porto-Power line, and consists of a pump and ram separated by a reinforced flexible hose. Because of



the remote-control feature, it is said the ram operates at full capacity in any direction, making it ideally adapted for vertical lifting or downward push in a press frame. The pump of the jack may be mounted on a portable wheeled stand or can be carried directly to the job. The ram unit is connected to the pump by an 8-ft. reinforced-steel mesh hose. Collapsed, the height of the ram is 10¼ in. The plunger travels 4½ in. and a screw extension of 3¾ in. gives an over-all height of 18 in.

Cutting Attachment

A new oxy-acetylene cutting attachment known as the Oxweld Type CW-22 was announced recently by The Linde Air



Products Company, 30 East 42d St., New York, N. Y. This new cutting attachment is said to incorporate features of design and possess a range and quality of performance which permit it to handle light sheet metal as well as all but the heaviest work at speeds and efficiency equal to those of the full-size cutting blowpipe. The attachment operates on low-pressure or medium-pressure acetylene with equally satisfactory results. Severe field tests are said to have proved its capacity, stability, and endurance under all conditions.

Hamerench

A pneumatic tool combining the actions of a hammer and a wrench, introducing a principle of operation said to be new, has been introduced by the Independent Pneumatic Tool Company, 600 West Jackson Boulevard, Chicago, Ill.

The Thor 603 Hamerench is said to remove all types of nuts in locomotive work, structural-steel work, shipyards, refineries, automobile plants, etc. Being of the right-angle type and operating horizontally to the application, this machine permits operation in places absolutely inaccessible to the straight machine. Constructed of alloy steel throughout, each of the operating parts is said to be of uniform strength. Nuts and flexible staybolt caps are said to be applied and removed by perfectly timed direct rapid hammer blows, delivered at right angles to the nut, an entirely new principle of operation. By changing the socket from one end of the spindle to the other end, the tool is made reversible. Force of torque is not employed; consequently there is no danger of shock to the operator.

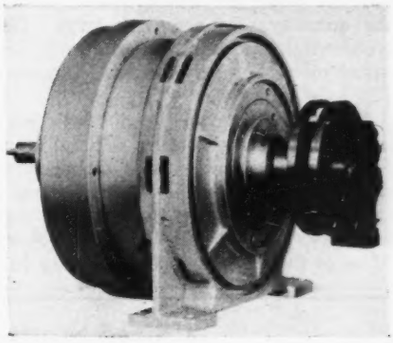
New Principle of Rotation For Stopehamer

Ingersoll-Rand, of Phillipsburg, N. J., recently announced a Stopehamer that is said to be faster and more powerful than any drill of that class built by that company. The new tool makes use of an entirely different method of rotating the drill steel. The customary pawls, pawl-springs, and ratchets are no longer used. A reciprocating motion is imparted to the rifle bar by the movement of the piston, assisted by air pressure applied alternately to the faces of the rifle-bar head. When the piston moves forward, the teeth of the rifle bar are said to be actually lifted out of engagement, and the bar is rotated freely. When the piston reverses, the teeth are forced back into engagement in an advanced position. The returning piston is rotated by the helical flutes of the locked rifle bar, causing the steel to rotate.

The rifle bar teeth are said to be held out of engagement by air pressure controlled by the throttle valve. Thus hammer action without rotation is available for collaring a hole. This pneumatic "on-off" control without extra levers or buttons is said to be made possible by the new rotation principle. The new hammer drill is made in two sizes designated "SAR 120" and "SAR 85." Both are said to be unusually light in weight and low in air consumption.

Magnetic Clutch-Brake

The Style "E" combination magnetic clutch-brake recently developed by the Magnetic Manufacturing Company, Milwaukee, Wis., is approximately 24 in. in



diameter, said to develop a clutch torque of 4,500 lb.-ft., and a brake torque of 1,500 lb.-ft. It was designed for a large rubber manufacturer, to incorporate features of smooth acceleration, lower power-factor losses, electrical control, elimination of mechanical parts requiring repair and replacement, and to give quick, automatic stopping with positive safety at all times even in the event of interruption in the electric circuit. The brake is said to be mechanically actuated through springs, and thus will stop the drive whenever the electric circuit is opened.

BULLETINS

Spectrometric Equipment. Bausch & Lomb Optical Co., Rochester, N. Y. Pp. 32.

M. S. A. Hydrogen Sulphide Detector, Mine Safety Appliances Co., Pittsburgh, Pa. Bulletin DY-2. Pp. 4.

Squirrel-Cage Induction Motors. Lincoln Electric Co., Cleveland, Ohio. Folder. Pp. 6. Price 10 cents.

"How to Cut Screw Threads." South Bend Lathe Works, South Bend, Ind. Bulletin 36A. Pp. 22. Also Bulletin 35 on "How to Grind Lathe Tool Cutter Bits." Pp. 14. Price 10c. each.

Hand Book of Refractories. Standard Fuel Engineering Co., 667 Post Ave. South, Detroit, Mich. Bulletin 37. On "Zero" brand refractories. Pp. 54.

Industrial Compressors, Vacuum Pumps. Ingersoll-Rand Co., 11 Broadway, New York. Catalog 7502-E. Compressors, single- and two-stage, ¼ to 15 hp., 1.2- to 102-cu.ft. per minute capacity, pressures up to 1,000 lb., vacuum pump, vacuums to within 0.35 in. of mercury. Pp. 28.

Micromax Electric Control. Leeds & Northrup Co., Philadelphia, Pa. Catalog N-OOA. For proportioning input to demand. Pp. 8.

Motor Reducers. Philadelphia Gear Works, Philadelphia, Pa. Bulletin MR36. On the Philadelphia MotoReducer. Pp. 28.

Air-cooled Riveting Hammers. Chicago Pneumatic Tool Co., Chicago, Ill. Bulletin on the Boyer riveting hammer. Pp. 4.

SUMMARY OF

MONTHLY COMMENT . . . DAILY AND AVERAGE MONTHLY

CONTRARY to expectations, July was one of the most active periods in trading in non-ferrous metals in recent years. Purchases of copper, on a monthly basis, were the largest on record in a peace-time market, and the price advanced one-quarter cent. Lead sales established a new high since 1929. Though zinc business suffered in comparison with the other major metals, the quantity sold also was large. Our weighted index number of non-ferrous metal prices for July was 72.18, against 72.02 in June.

Sales of copper in the domestic market during July totaled 175,484 tons, most of which was for October shipment to consumers. This total compares with 16,521 tons in June, 16,303 tons in May, and 158,064 tons in April. Most of the business booked during July was placed just before the advance in the price to 9.75c., Valley, became effective. Encouraging reports on the trend of business in industries that are important consumers of copper made buyers even more enthusiastic than on previous occasions when producers gave notice of a higher market. Domestic production is not expected to be increased until after the price rises further.

Foreign call for copper was fairly active on good demand for industrial consumption and armament requirements. Effective Aug. 1, foreign producers participating in the curtailment agreement increased production 5 per cent, or to the basis of about 75 per cent of capacity. This will add a little more than 3,250 tons of mine output monthly to foreign production. World stocks of refined copper on July 1 totalled 458,914 short tons, approximately three months' consumption.

About 60,000 tons of lead were sold in the domestic market during July. With producers greatly concerned about reducing surplus stocks of lead to a normal basis, the price was maintained at 4.60c., New York, and 4.45c., St. Louis. Refined-lead stocks at the end of June amounted to 230,481 tons.

Prime Western zinc declined to 4.75c., St. Louis, early in the month on continued weakness in the London quotations. A moderate recovery in London and a renewal of buying interest here caused the price to move up to 4.80c.

Tin was unsettled on conflicting reports in connection with the renewal of the control plan that expires at the end of this year.

United States Market

1936 July	Electrolytic Copper Domestic (a)	Electrolytic Copper Export (b)	Straits Tin New York	Lead New York	Lead St. Louis	Zinc St. Louis
1	9.275	8.825	40.550	4.60	4.45	4.85
2	9.275	8.850	40.500	4.60	4.45	4.85
3	9.275	8.850	40.625	4.60	4.45	4.85
4	Holiday	8.875	Holiday	Holiday	Holiday	Holiday
6	9.275	8.875	41.675	4.60	4.45	4.85
7	9.275	8.875	42.125	4.60	4.45	4.75
8	9.275	8.875	43.400	4.60	4.45	4.75
9	9.275	8.875	43.500	4.60	4.45	4.75
10	9.275	8.900	43.375	4.60	4.45	4.75
11	9.275	8.925	43.500	4.60	4.45	4.75
13	9.275	8.925	44.750	4.60	4.45	4.75
14	9.275	8.925	44.375	4.60	4.45	4.75
15	9.275	8.925	44.300	4.60	4.45	4.75
16	9.275	8.950	43.500	4.60	4.45	4.75
17	9.275	8.975	43.250	4.60	4.45	4.75
18	9.275	8.975	43.625	4.60	4.45	4.75
20	9.275	9.075	44.250	4.60	4.45	4.75
21	9.275	9.125	43.725	4.60	4.45	4.75
22	9.275	9.150	44.000	4.60	4.45	4.80
23	9.525	9.150	43.625	4.60	4.45	4.80
24	9.525	9.100	43.425	4.60	4.45	4.80
25	9.525	9.125	43.625	4.60	4.45	4.80
27	9.525	9.125	42.000	4.60	4.45	4.80
28	9.525	9.150	42.125	4.60	4.45	4.80
29	9.525	9.175	43.150	4.60	4.45	4.80
30	9.525	9.100	42.825	4.60	4.45	4.80
31	9.525	9.125	42.750	4.60	4.45	4.80
Av. for month	9.352	8.993	43.021	4.60	4.45	4.783
Averages for Week						
July						
1	9.275	8.850	40.808	4.60	4.45	4.850
8	9.275	8.867	41.665	4.60	4.45	4.810
15	9.275	8.913	43.967	4.60	4.45	4.750
22	9.275	9.042	43.725	4.60	4.45	4.758
29	9.525	9.138	42.992	4.60	4.45	4.800
Calendar Week Averages						
July						
4	9.275	8.846	40.655	4.60	4.45	4.850
11	9.275	8.888	42.929	4.60	4.45	4.767
18	9.275	8.946	43.967	4.60	4.45	4.750
25	9.400	9.121	43.775	4.60	4.45	4.783

Silver, Gold, and Sterling Exchange New York and London

1936 July	Sterling Exchange "Checks"	Sterling Exchange "90-day demand"	Silver (c) New York	Silver London	Gold London	Gold (d) United States
1	5.01500	5.00000	44.750	19.4375	139s ¼d	$35.00
2	5.02000	5.00500	44.750	19.5000	139s 1d	35.00
3	5.02250	5.00875	44.750	19.3750	138s 11 d	35.00
4	Holiday	Holiday	Holiday	19.5000	139s 1¼d	Holiday
6	5.02000	5.00625	44.750	19.5625	138s 11¼d	35.00
7	5.02000	5.00625	44.750	19.6250	139s	35.00
8	5.01875	5.00625	44.750	19.5625	139s	35.00
9	5.01875	5.00750	44.750	19.6875	139s 1 d	35.00
10	5.02125	5.01000	44.750	19.7500	139s	35.00
11	5.02875	5.01875	(e)	19.5625	138s 8 d	35.00
13	5.02625	5.01500	44.750	19.6875	138s 8¼d	35.00
14	5.02500	5.01375	44.750	19.6250	138s 10 d	35.00
15	5.02500	5.01375	44.750	19.7500	139s	35.00
16	5.02625	5.01500	44.750	19.6875	138s 11 d	35.00
17	5.02625	5.01500	44.750	19.6250	138s 10 d	35.00
18	5.03125	5.02125	(e)	19.6250	138s 9 d	35.00
20	5.03000	5.01875	44.750	19.6250	138s 7 d	35.00
21	5.02625	5.01625	44.750	19.6875	138s 9 d	35.00
22	5.02375	5.01250	44.750	19.6250	138s 10 d	35.00
23	5.01750	5.00750	44.750	19.6250	138s 8¼d	35.00
24	5.01500	5.00500	44.750	19.6250	138s 10 d	35.00
25	5.02125	5.01125	(e)	19.6875	138s 10¼d	35.00
27	5.01875	5.00875	44.750	19.5625	138s 10 d	35.00
28	5.01625	5.00625	44.750	19.5625	138s 11 d	35.00
29	5.01875	5.00875	44.750	19.4375	138s 10 d	35.00
30	5.01875	5.00875	44.750	19.4375	138s 9¼d	35.00
31	5.01500	5.00500	44.750	19.5000	138s 9¼d	35.00
Av. for month	5.02178	.....	41.750	19.590	.....	35.00
Averages for Week						
July						
1	5.02063	.....	44.750	.....	.....	.....
8	5.02025	.....	44.750	.....	.....	.....
15	5.02417	.....	44.750	.....	.....	.....
22	5.02729	.....	44.750	.....	.....	.....
29	5.01792	.....	44.750	.....	.....	.....

Calendar week averages: New York Silver, July 4th, 44.750; 11th, 44.750; 18th, 44.750; 25th, 44.750.

(e) No quotation.

The above quotations for major non-ferrous metals are our appraisal of the important United States markets, based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

(a) Net prices at refineries on Atlantic seaboard. To arrive at the delivered New England basis, add 0.225c. per pound, the average differential for freight and interest charges.

(b) Export prices are net at refineries on the Atlantic seaboard and include sales of domestic copper in the foreign market. Most sales in the foreign market are made on the basis of c.i.f. usual ports of destination—Hamburg, Havre, and Liverpool. The c.i.f. basis commands a premium of 0.300c. per pound above our refinery quotation.

Copper, lead and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

Quotations for copper are for the ordinary forms of wirebars and ingot bars; cathodes are sold at a discount of 0.125c.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York commands a premium over the St. Louis basis equal to the freight differential. Contract prices for High Grade zinc delivered in the East and Middle West in nearly all instances command a premium of 1c. per pound over the current market for Prime Western but not less than the *E. & M. J.* average for Prime Western for the previous month.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

(c) Silver other than newly mined domestic. Under Executive order issued April 24, 1935, the U. S. Government's price on newly mined domestic silver was established at 77.57. Handy & Harman's quotation for domestic silver, .999 fine, was 77c. per ounce throughout July.

(d) U. S. Treasury's gold price. Actual payment by the United States Treasury for gold in imported ore or concentrate is at 99.75 per cent of the price quoted by the Treasury, which at present is equal to $34.9125 per ounce.

THE MARKETS

PRICES OF METALS . . . MISCELLANEOUS QUOTATIONS

London Market

1936 July	Copper Standard Spot	Copper Standard 3M	Copper Electrolitic Bid	Tin Standard Spot	Tin Standard 3M	Lead Spot	Lead 3M	Zinc Spot	Zinc 3M
1	36.5625	36.8125	40.5000	178.2500	175.2500	15.1875	15.3125	13.3750	13.6875
2	36.5625	36.8750	40.5000	175.7500	173.0000	15.3125	15.4375	13.3750	13.6875
3	36.6875	37.0000	40.7500	175.0000	172.2500	15.3125	15.5000	13.4375	13.7500
6	36.8125	37.1250	40.7500	180.0000	177.5000	15.4375	15.5625	13.5000	13.8125
7	36.8125	37.0625	40.7500	182.5000	179.0000	15.3750	15.5000	13.3750	13.6875
8	36.6250	36.9375	40.7500	188.7500	183.2500	15.3750	15.5000	13.1875	13.4375
9	36.8125	37.0625	40.8750	188.5000	184.5000	15.5000	15.6875	13.3125	13.5625
10	36.8750	37.1875	40.8750	186.5000	182.2500	15.5000	15.6875	13.1875	13.4375
13	36.9375	37.2500	40.8750	193.5000	190.0000	15.3750	15.6250	13.3750	13.6250
14	36.8750	37.1875	40.7500	192.5000	187.5000	15.3750	15.6250	13.3750	13.6250
15	36.9375	37.2500	41.0000	192.5000	188.0000	15.3750	15.6250	13.4375	13.6875
16	37.0000	37.3125	41.1250	189.5000	184.7500	15.5000	15.7500	13.4375	13.6875
17	37.0000	37.3125	40.8750	187.2500	183.1250	15.6250	15.8750	13.4375	13.6875
20	37.5625	37.8750	41.5000	190.5000	187.5000	16.1250	16.2500	13.6875	13.9375
21	37.7500	38.0625	41.8750	189.5000	186.0000	16.5000	16.5000	13.9375	14.1875
22	37.6875	38.0000	42.0000	189.7500	187.0000	16.6250	16.6875	13.8750	14.1875
23	37.6875	38.0000	41.8750	189.7500	186.7500	16.3750	16.4375	13.7500	14.0000
24	37.6875	37.9375	41.7500	188.7500	185.5000	16.3125	16.3750	13.6875	13.9375
27	37.8125	38.0625	41.7500	185.0000	182.0000	16.5625	16.5000	13.7500	14.0000
28	37.9375	38.2500	41.8750	179.5000	176.2500	16.5000	16.4375	14.0000	14.1875
29	37.9375	38.2500	42.0000	184.0000	180.7500	16.4375	16.3750	14.0625	14.1875
30	37.6250	37.8750	41.5000	185.0000	182.0000	16.2500	16.1875	13.8750	14.0000
31	37.8125	38.0625	41.7500	184.7500	181.5000	16.7500	16.5000	13.8750	14.0000
Av. for month	37.217	.....	41.228	185.957	.....	15.856	15.954	13.579	13.826

Current Prices—Miscellaneous Metals, Ores, and Non-Metallic Minerals

Quotations cover wholesale lots, prompt shipment, f.o.b. New York, unless otherwise stated
(August 1, 1936)

Miscellaneous Metals

Aluminum, ingot, 99 plus per cent, lb	19@21c.
Antimony, domestic, spot, lb	11.375c.
Bismuth, ton lots, lb	$1.00
Cadmium, lb	75c@$1.05
Chromium, 97 per cent grade, lb	85c.
Nickel, electrolytic cathodes, lb	35c.
Magnesium, 99.8 per cent, carloads, lb	30c.
Palladium, troy oz	$24.00
Platinum, (official quotation) troy oz	$40.00
Quicksilver, flask of 76 lb., 100 flasks or more	$73.25
Radium, mg. radium content	$40.00
Selenium, 99.5 per cent, lb	$2.00
Silicon, minimum 97 per cent, spot, lb	16.50c
Tellurium, lb	$1.75@$2.00
Thallium, 100 lb. or more, lb	$6.50
Titanium, 96 to 98 per cent, lb	$6.00
Zirconium, commercially pure, lb	$7.00

Metallic Ores

Beryllium Ore, f.o.b. mines, ton	$30.00@$35.00
Chrome Ore, 45@47 per cent, c.i.f., long ton	$16.00@$16.50
Iron Ore, Lake Superior, long ton:	
Old Range bessemer	$4.80
Mesabi bessemer	$4.65
Old Range non-bessemer	$4.65
Mesabi, non-bessemer	$4.50
Lead (Galena) 80 per cent Joplin, Mo., ton	$49.00
Manganese Ore, c.i.f. Atlantic ports, long ton unit:	
52@55 per cent	26c.
49@51 per cent	26c.
44@47 per cent	25c.
Molybdenum Ore, 90 per cent, per lb. of contained MoS_2	42c.
Tungsten Ore, per unit of WO_3:	
Chinese duty paid	$14.00
Domestic Scheelite	$14.00
Vanadium Ore, per lb. of contained V_2O_5	27½c.
Zinc Ore, Prime, 60 per cent concentrate, Joplin, Mo.; per ton	$31.00

Metallic Compounds

Arsenious Oxide (arsenic) lb	3½c.
Cobalt Oxide, 70@71 per cent, lb	$1.41@$1.51
Copper Sulphate, 100 lb	$4.00
Sodium Nitrate, ex vessel, in 200-lb. bags, per 100 lb	$1.29
Sodium Sulphate, bulk, ton	$13.00@$15.00

Alloys

Beryllium-Copper, Master alloy, 2.5 to 3 per cent Be, per lb. of contained Be	$30.00
Ferrochrome, 65@70 per cent chromium, 4@6 per cent carbon, lb	10c.
Ferromanganese, 78@82 per cent, gross ton	$75.00
Ferromolybdenum, 50@60 per cent Mo, lb. of Mo contained	95c.
Ferrosilicon, 50 per cent, gross ton	$69.50
Ferrotungsten, 75@80 per cent, lb. of W contained	$1.30@$1.40

Non-Metallic Minerals

Asbestos, f.o.b. mines ton:	
Canadian (Quebec)	
Crude No. 1	$550@.....
Crude No. 2	$200@$225
Spinning fibers	$90@$150
Paper stock	$32.50@$37.50
Shorts	$11@$14.50
Vermont	
Shingle stock	$47.50.....
Paper stock	$35@.....
Cement stock	$23@.....
Barytes, long ton:	
Georgia, crude	$7.00
Missouri, 95 per cent $BaSO_4$, less than 1 per cent iron	$5.50
Bauxite, long ton:	
Domestic, chemical, 55@58 per cent	$6@ $7.50
Domestic, abrasive, 78@84 per cent	$12.50@$15.00
Dalmatian, 50@55 per cent	(a)$5.50@ $7.00
French, 56@59 per cent	(a)$6.50@ 7.50
China Clay, f.o.b. mines, ton:	
South Carolina and Georgia, bulk	$7.00@ $9.00
Delaware, No. 1	$14.00@.....
Feldspar, bulk, ton:	
Potash feldspar, 200 mesh	$17.00
Glass-spar, white, 20 mesh	$11.75
Fluorspar, f.o.b. mines, bulk, Kentucky and Illinois 85-5 per cent, all rail movement, ton	$18.00
Fuller's earth, f.o.b. Georgia or Florida, ton	$7.00@$14.00
Magnesite, per ton:	
Dead-burned, f.o.b. California	$25.00@.....
Dead-burned, f.o.b. Washington	$22.00@.....
Mica, per lb., North Carolina, No. 1 and 2 quality:	
1½ x 2 in	15@30c.
2 x 2 in	30@50c.
3 x 3 in	75@$1.00
3 x 4 in	$1.00@$1.25
4 x 6 in	$2.00@$2.50
White, ground, 70 mesh, ton	$60.00@$80.00
Ocher, Georgia, ton	$19.00@$22.50
Pyrites, Spanish, per long ton unit of S, c.i.f. Atlantic ports	(a)12@12½c.
Silica, water-floated, in bags, 325 mesh, ton	$16.00@$40.00
Sulphur, Texas mines, long ton	$18.00@.....
Talc, f.o.b. works, ton:	
New York, double air-floated, 325 mesh	$12.00@$15.00
New Jersey, mineral pulp	$8.00@$10.00
Vermont, extra white, 200 mesh	$8.50@ $9.00
Tripoli, Missouri, ton:	
40 mesh, cream colored	$15.00@.....
200 mesh, cream colored	$25.00@.....

(a) Nominal.

Iron and Steel

Pig Iron, Valley furnaces, gross ton:	
Bessemer	$20.00
Basic	$19.00
No. 2 Foundry	$19.50
Steel, base prices, Pittsburgh:	
Billets, gross ton	$30.00
Structural shapes, 100 lb	$1.90
Bars, 100 lb	$1.95

MONTHLY AND YEARLY AVERAGE PRICES

Silver and Sterling Exchange

	New York		London Spot		Sterling Exchange	
	1935	1936	1935	1936	1935	1936
January	54.418	47.250	24.584	20.250	489.207	496.115
February	54.602	44.750	24.818	19.796	487.278	499.908
March	59.048	44.750	27.380	19.663	477.635	496.952
April	67.788	44.892	30.986	20.245	483.596	494.139
May	74.356	44.869	33.865	20.248	488.587	496.850
June	71.940	44.750	32.346	19.770	493.245	501.817
July	68.216	44.750	30.500	19.590	495.558	502.178
August	66.366	.....	29.476	.....	496.815	.....
September	65.375	.....	29.255	.....	492.917	.....
October	65.375	.....	29.368	.....	490.577	.....
November	65.375	.....	29.284	.....	492.277	.....
December	58.420	.....	25.563	.....	492.715	.....
Year	64.273	.....	28.952	.....	490.034	.....

New York quotations for silver not eligible for sale to U. S. Government, cents per ounce troy, 999 fine. London, pence per ounce sterling silver 925 fine. Sterling exchange in cents.

Copper

	F.O.B. Refinery, Electrolytic				London Spot			
	Domestic		Export		Standard		Electrolytic (a)	
	1935	1936	1935	1936	1935	1936	1935	1936
January	8.775	9.025	6.583	8.358	28.077	34.706	31.261	38.788
February	8.775	9.025	6.341	8.566	27.175	35.313	30.244	39.463
March	8.775	9.025	6.526	8.708	28.518	36.040	31.607	40.227
April	8.775	9.169	7.328	8.849	31.231	36.975	34.763	41.131
May	8.775	9.275	7.794	8.819	33.344	36.690	36.733	40.839
June	8.634	9.275	7.307	8.790	30.799	36.324	34.039	40.357
July	7.775	9.352	7.350	8.993	31.024	37.217	34.261	41.228
August	7.979	.....	7.738	.....	32.646	.....	35.976	.....
September	8.504	.....	8.146	.....	34.036	.....	37.952	.....
October	8.967	.....	8.514	.....	35.226	.....	39.609	.....
November	9.025	.....	8.414	.....	35.229	.....	39.396	.....
December	9.025	.....	8.414	.....	35.097	.....	39.313	.....
Year	8.649	.....	7.538	.....	31.867	.....	35.430	.....

New York quotations, cents per pound. London, pounds sterling per long ton (a) Bid quotation.

Lead

	New York		St. Louis		London			
					1935	1935	1936	1936
	1935	1936	1935	1936	Spot	3 Mos.	Spot	3 Mos
anuary	3.692	4.500	3.542	4.350	10.321	10.514	15.397	15.49
February	3.528	4.515	3.378	4.365	10.216	10.413	16.022	16.141
March	3.579	4.600	3.429	4.450	11.012	11.188	16.608	16.767
April	3.692	4.600	3.542	4.450	12.231	12.459	16.097	16.234
May	3.962	4.600	3.812	4.450	13.861	13.940	15.530	15.601
June	4.020	4.600	3.870	4.450	13.776	13.806	15.170	15.259
July	4.123	4.600	3.973	4.450	14.451	14.511	15.856	15.954
August	4.254	.....	4.104	.....	15.774	15.792	.....	.....
September	4.413	.....	4.263	.....	16.262	16.315	.....	.....
October	4.512	.....	4.362	.....	18.209	18.209	.....	.....
November	4.500	.....	4.350	.....	17.938	17.935	.....	.....
December	4.500	.....	4.350	.....	16.803	16.828	.....	.....
Year	4.065	.....	3.915	.....	14.238	14.326	.....	.....

New York and St. Louis quotations, cents per pound. London pounds sterling per long ton.

Tin

	Straits New York		Standard, Spot London	
	1935	1936	1935	1936
January	50.916	47.234	231.193	209.731
February	50.063	47.962	227.381	207.081
March	46.962	48.037	215.726	213.080
April	50.154	46.963	223.513	209.313
May	51.138	46.352	227.602	202.429
June	51.108	42.204	227.586	183.167
July	52.297	43.021	232.397	185.957
August	50.463	.....	222.935	.....
September	49.126	.....	223.929	.....
October	51.160	.....	226.891	.....
November	51.864	.....	226.452	.....
December	49.794	.....	220.075	.....
Year	50.420	.....	225.473	.....

New York quotations, cents per pound. London, pounds sterling per long ton.

Zinc

	St. Louis		London			
	1935	1936	1935 Spot	1935 3 Mos.	1936 Spot	1936 3 Mos
January	3.730	4.848	11.994	12.207	14.488	14.719
February	3.714	4.859	11.819	12.000	15.125	15.391
March	3.894	4.900	12.095	12.250	15.983	16.190
April	4.030	4.900	12.891	13.128	15.181	15.334
May	4.220	4.900	14.534	14.685	14.536	14.777
June	4.299	4.880	13.734	13.898	13.896	14.122
July	4.325	4.783	14.065	14.185	13.579	13.826
August	4.535	.....	14.714	14.938	.....	.....
September	4.669	.....	15.414	15.616	.....	.....
October	4.825	.....	16.440	16.674	.....	.....
November	4.850	.....	16.193	16.372	.....	.....
December	4.850	.....	15.091	15.278	.....	.....
Year	4.328	.....	14.082	14.269	.....	.....

St. Louis quotations, cents per pound. London, pounds sterling per long ton.

Cadmium and Aluminum

	Cadmium		Aluminum	
	1935	1936	1935	1936
January	55.000	105.000	20.000	20.000
February	55.000	105.000	20.000	20.000
March	58.462	105.000	20.000	20.000
April	65.000	105.000	20.000	20.000
May	65.000	105.000	20.000	20.000
June	65.000	105.000	20.000	20.000
July	65.000	93.462	20.000	20.000
August	70.000	.....	20.000	.....
September	75.625	.....	20.000	.....
October	85.000	.....	20.000	.....
November	85.000	.....	20.000	.....
December	101.800	.....	20.000	.....
Year	70.491	.....	20.000	.....

Aluminum in cents per pound, 99 per cent grade. Cadmium, cents per pound.

Antimony, Quicksilver, and Platinum

	Antimony (a) New York		Quicksilver (b) New York		Platinum (c) New York	
	1935	1936	1935	1936	1935	1936
January	14.111	12.736	72.760	76.769	34.000	36.885
February	14.250	12.967	72.500	77.000	34.000	35.000
March	14.250	13.072	72.500	77.000	32.846	34.115
April	14.029	12.673	72.500	76.731	32.000	32.846
May	12.712	12.410	72.135	74.940	32.000	32.000
June	12.500	11.707	71.460	74.192	32.000	36.346
July	12.500	11.245	70.538	73.423	32.000	39.308
August	12.500	.....	69.000	.....	31.333	.....
September	13.177	.....	69.208	.....	36.000	.....
October	15.322	.....	71.750	.....	37.615	.....
November	14.217	.....	74.348	.....	38.000	.....
December	13.820	.....	75.200	.....	38.000	.....
Year	13.616	.....	71.992	.....	34.150	.....

(a) Antimony quotations in cents per pound, for ordinary brands. (b) Quicksilver in dollars per flask of 76 lb. (c) Platinum in dollars per ounce troy.

Pig Iron

	Bessemer		Basic		No. 2 Foundry	
	1935	1936	1935	1936	1935	1936
January	19.00	20.00	18.00	19.00	18.50	19.50
February	19.00	20.00	18.00	19.00	18.50	19.50
March	19.00	20.00	18.00	19.00	18.50	19.50
April	19.00	20.00	18.00	19.00	18.50	19.50
May	19.00	20.00	18.00	19.00	18.50	19.50
June	19.00	20.00	18.00	19.00	18.50	19.50
July	19.00	20.00	18.00	19.00	18.50	19.50
August	19.00	.....	18.00	.....	18.50	.....
September	19.00	.....	18.00	.....	18.50	.....
October	19.00	.....	18.00	.....	18.50	.....
November	20.00	.....	19.00	.....	19.50	.....
December	20.00	.....	19.00	.....	19.50	.....
Year	19.167	.....	18.167	.....	18.667	.....

Iron in dollars per long ton. F.o.b. Mahoning and Shenango Valley furnaces.